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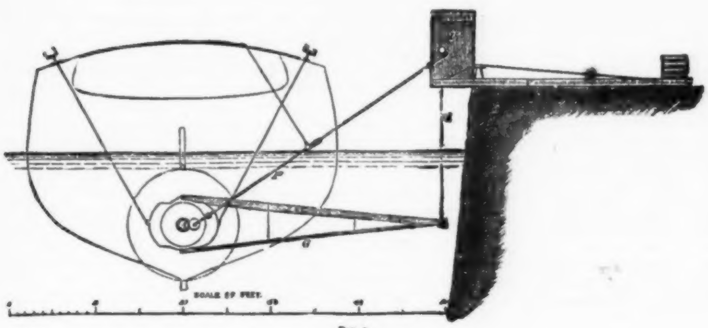


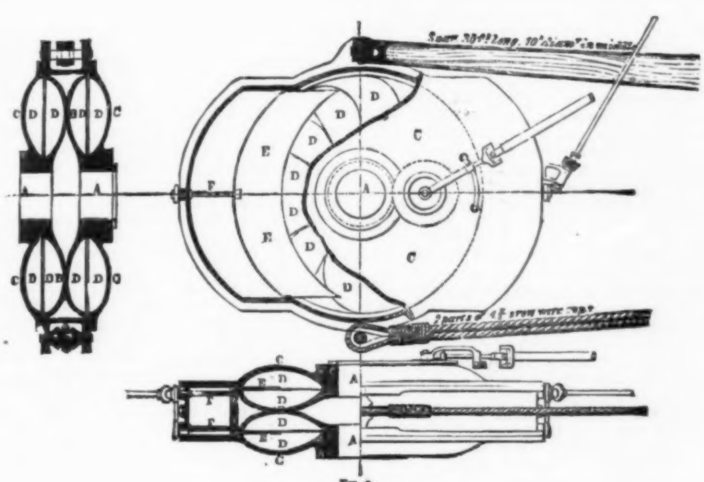
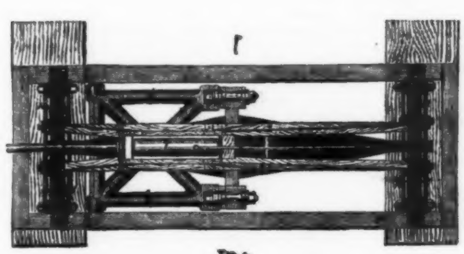
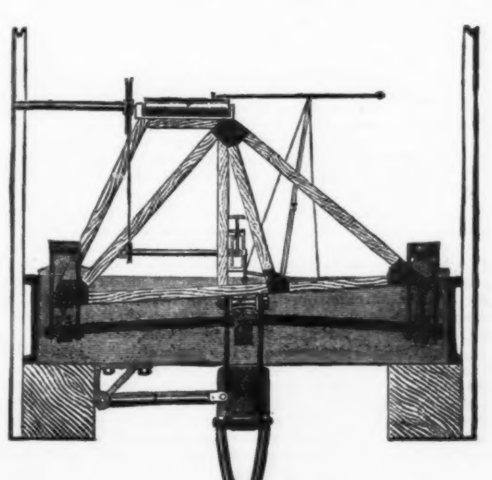


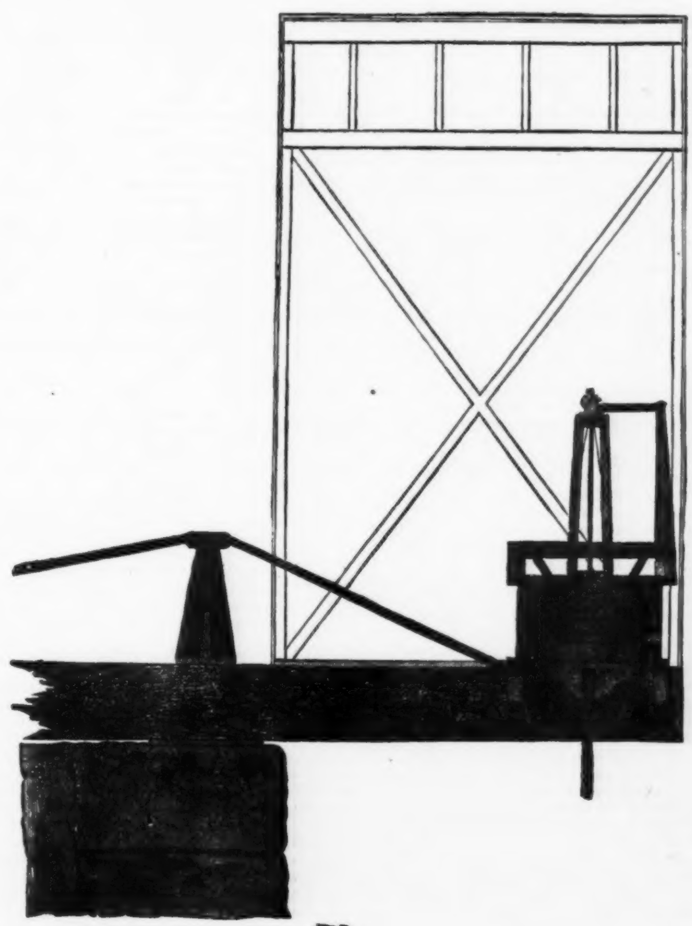
Fig. 1 is a general view of the dynamometer attached to the screw-shaft; fig. 2, an enlarged view of the instrument; fig. 3 is a plan; fig. 4, a section; and fig. 5, a view of the integrating apparatus. The letters fo reference are similar in all the figures, and the following list is self-explanatory.

TABLE OF REFERENCE LETTERS USED IN DIAGRAMS.

A. Screw-shaft.
B. Turbine.
C. Casing.
D. Diaphragms.
E. Sliding regulating shutters.
F. Screws for moving E, governed by telescopic rods actuating bevel gear controlled from ship's deck.
G. Lever for holding casing.
H. Links connecting G with dynamometric apparatus.
K. Knife-edged gimbal for carrying strain of H to spring.
L. Framed radius for guiding K and eliminating oblique strains.
M. Dynamometer spring.
N. Suspension links carrying the ends of M.
O. Feeler conveying elastic motion of M.
P. Telescopic rod taking rotation of screw-shaft by bevel gear and communicating it to integrating apparatus.
Q. Motion axis of integrating apparatus governed by O.
R. Automatic integrator.
S. Bell crank for magnifying motion of O and conveying it to paper cylinder.
T. Paper cylinder recording magnified motion of O.
The graphic integration of the record given by T is comparable with the automatic integration given by R.
U. Shed conveying integrating apparatus.
V. Strong balk brackets upholding U.







NEW DYNAMOMETER FOR MEASURING THE POWER DELIVERED TO THE SCREWS OF SHIPS.
BY WILLIAM FROUDE, F.R.S.

ON A NEW DYNAMOMETER FOR MEASURING THE POWER DELIVERED TO THE SCREWS OF LARGE SHIPS.

IN the preparation of the design of a dynamometer calculated to test the power delivered at the end of the screw-shaft by large-sized marine engines—a duty assigned to the writer by the Admiralty—the well-known friction brake, which he had in view when first entering on the inquiry, proved to involve greater difficulties than was anticipated, and the result was to induce him to search for some essentially different point of departure; and in describing that which he was fortunate enough to discover, and in explaining the apparatus which embodies it, the disadvantages of the friction brake will be sufficiently explained. In the friction-brake dynamometer the power delivered to a revolving shaft is measured by the rate at which a definite weight is being virtually lifted or virtually drawn up out of a well of indefinite depth; and the number of foot-pounds of work done per minute is the circumference of the drum at the effective radius at which the weight is lifted, multiplied by the weight and by the number of revolutions per minute; and the effect of a greater or less delivery of power will be a variation, not in the driving force, but in the speed of rotation. This arrangement involves serious difficulties when employed on a large scale; of these the most intractable is the great amount of heat developed between the rubbing surfaces, when the horse-power is being counted by thousands instead of by tens; and it was chiefly in order to escape this difficulty that the writer sought some fresh *modus operandi*, and ultimately felt his way to the arrangement now to be described as a substitute. Under this arrangement it will still happen that the engine in delivering its power will be virtually winding up a weight out of a well of indefinite depth; but the weight will vary with the speed of rotation, and thus the work performed will more closely resemble its natural work, though the same circumstance renders necessary an automatic method of recording the variations of the resistance (or of the weight that is in effect being lifted), which occur during the trial. The reaction, instead of arising from the continuous friction of two solid surfaces, will consist of a multitude of reactions supplied by the impact of a series of fluid jets or streams, which are maintained in a condition of intensified speed by a sort of turbine revolving within a casing filled with water, both the turbine and the casing being mounted on the end of the screw-shaft in place of the screw, the turbine revolving while the casing is dynamometrically held stationery; the jets being alternately dashed forward from projections in the turbine against counter-projections in the interior of the casing, tending to impress forward rotation on it, and in turn dashed back from the projections in the casing against those

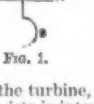


FIG. 1.

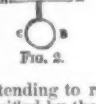


FIG. 2.

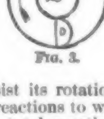


FIG. 3.

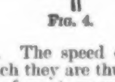


FIG. 4.

in the turbine, tending to resist its rotation. The speed of the jets is intensified by the reactions to which they are thus alternately subjected; and a total reaction of great magnitude is maintained within a casing of comparatively limited dimensions. The nature of this arrangement was illustrated by a series of skeleton sketches. In Fig. 1, A A represents the screw-end of the screw shaft: B B shows in section what has been termed "the turbine;" it is a disk or circular plate, with a central boss, keyed to the screw-shaft in place of the screw, and revolving with the shaft. The disk is not flat through its entire zone, being shaped into a channel of semi-oval section, which sweeps round the whole circumference concentrically to the axis. To give definiteness to the conception, imagine that, to deal with an engine of 2,000 indicated horse-power, the diameter of the turbine-disk to the outer border of the channel is 5 feet. In Fig. 2, Fig. 1 is repeated, and what has been called "the casing" is added, being indicated by the letters C C, D D, the former representing the front, and the latter the back. The face carries a channel, the counterpart of that carried by the disk, which it also fronts precisely, so that the two semi-oval channels in effect form one complete oval channel, though the two halves are in substance separated by an imaginary plane of division. The back of the casing embraces or includes the disk entirely, but without touching it; the casing is also provided with a boss, which is an easy fit over that of the disk or turbine, and thus the disk carried by the shaft can revolve within the casing without touching it, while the casing itself is stationary, and one half of the oval channel is running round while the other half is at rest. Thus far the two half channels have been regarded as open and unobstructed; they are, however, in fact, each closed or cut across by a series of fixed diaphragms, a single one of which is shown in Fig. 3, as in its place in the disk-channel, which cut the channel, not perpendicularly, but obliquely, being semicircular in outline, so that when set obliquely their circular edges fit the oval bottom of the channel, while their diameters span the major axis of the oval. Fig. 4 shows one of the diaphragms seen end-on or edgeways, as it would appear in an edgeways view of the disk if this were transparent. Each half channel has twelve of these diaphragms, and is thus divided into a series of cells, each of which, if viewed at right angles to one of the diaphragms, is semicircular in outline; and if thus viewed in connection with the cell which is for the moment opposite to it in the counterpart half channel, the two together make one complete cell with circular outline. Thus the whole oval channel may be regarded as a series of obliquely-placed circular cells, and as the function of the disk or turbine is to rotate while the casing remains at rest, one half of each cell is moving past the other half in such a manner that the moving half, if viewed from its stationary counterpart, would, by reason of the oblique direction of the diaphragms which form the cell's sides, appear to be advancing antagonistically towards it; indeed the motion virtually constitutes such an advance, because the bottom of each moving half cell is continually growing nearer to the bottom of the stationary half cell which it faces. The channel and the whole casing is filled with water, and the disk or turbine is made to rotate as described. When the turbine is thus put in motion, the water contained in each of its half cells is urged outwards by centrifugal force, forcing inwards the water contained in the stationary casing half-cells, and thus a continuous current is established, outward in the turbine's half-cells, inward in those of the casing. The current possesses a vitality and power of growth dependent on what has been termed the virtually antagonistic attitude or motion of the two sets of diaphragms, and the cells of which they are the boundaries. The general arrangement of the dynamometer is illustrated on page 133. With any given speed of the turbine, the system of internal motion involves a "potential" or definite speed-producing power, which will continue to increase the speed of the currents until the friction experienced by them in traversing the cells produces a resistance equal to the potential. This frictional resistance, as well as the potential itself, are alike proportioned to the square of the speed of the turbine, and thus the resulting speed of current is directly proportional to the speed of the turbine simply. The volume of water which constitutes the current in each complete cell may be regarded as a circular plane or disk of water, rotating in its own plane between the diaphragms, which defines the direction of the water disk and which are the boundaries of its thickness. As the diaphragms radiate from a center, the disks of water which they enclose will not be of parallel thickness throughout, the part furthest from the center being thicker than that nearest to it; but this circumstance does not really affect the result. Each of these rotating circular water disks may now be clearly regarded as subdivisible into, or consisting of, a series of hoop-shaped pipes or tubes of infinitesimal thickness laid one within the other, and each filled with a stream of some appropriate speed, the sides of the pipes being merely imaginary boundaries; and the disk made of these streams will constitute a sort of vortex. Now each vortex, in virtue of the centrifugal force which is continually tending to stretch it edgeways, pushes against its circumferential boundaries, and as these boundaries are in fact made up of the top and bottom of the cell occupied by the vortex (the top in the stationery casing and the bottom in the rotating turbine), the resultant force, measured in the plane of the rotation of the turbine, is constantly tending with a determinate force to stop the rotation of the turbine, and to create rotation in the casing. A simple way of expressing the magnitude of this force is to regard it as due to the reversal, in each semi-revolution of the vortex (that is in the traverse of each half cell), of the aggregate momentum of the vortex streams, measured in the plane of rotation of the turbine; for the streams, which on entering the cell are flowing in one direction, are flowing in the opposite direction with precisely the same speed on leaving it, and the force due to the reversal is directly proportionate to the amount of momentum reversed per second. This is as the product of the mass acted on per second and the change of speed imparted to it in the plane of rotation of the turbine; this change of speed is plainly twice the speed of the turbine, and the mass acted on per second is as the mean speed of the vortex current, which, as has been already explained, bears a constant relation to the speed of the turbine; so that the tendency of each vortex to stop the rotation of the turbine, and to give rotation to the casing, is as the square of the speed of the turbine. This element of reaction would continue to act for a while, even if the turbine were suddenly brought to rest; for the vortical rotation to which it is due would continue, though with gradually diminishing speed, until it was extinguished by friction; but there remains another element of reaction which exists only while the turbine is in rotation. The imaginary hoop-shaped streams, of which each vortex is made up, are perpetually being severed or "sheared" by the passage of the planes of the turbine diaphragms past those of the casing diaphragms. In virtue of this action, the particles which constitute each stream must, at the points of shearing, be perpetually undergoing alternate changes of speed, backwards and forwards in the plane of rotation of the turbine, for as they pass from the stationary casing cells, to the rotating turbine cells, they are obliged to assume the speed of the turbine in its plane of rotation, and they thus react on the turbine diaphragms with a definite force, due to the amount of momentum per second imparted to them in transition; and again, as they pass from the rotating turbine cells to the stationary casing cells, they are obliged to lose that speed in the plane of turbine rotation, and they thus act on the casing cells, tending to push them forward, with the same force with which their reaction tended to push back or stop the rotation of the turbine cells. The same force, because the same mass per second, is acted on in both instances, and the same speed is in the one instance imparted, in the other instance taken away. Thus the reaction is as the square of the speed of rotation, since the momentum generated per second (on which the reaction depends) is as the product of the mass operated on per second and the speed imparted to it; now the speed imparted is simply the speed of the turbine, and the mass operated on is as the speed of vortical rotation, which, as already explained, is necessarily as the speed of the turbine.

Having now traced the *modus operandi* by which the reaction is produced, and having seen that with an instrument of given dimensions the reaction will be as the square of the speed of rotation of the shaft to which it is attached, it is necessary to show that (1) an adequate amount of total reaction can be produced by an instrument of conveniently limited dimensions; and that (2) an instrument of given dimensions is governable as regards its reactions, that is to say, is capable of being made to produce at pleasure a greater or less reaction with a given number of revolutions, so that within reasonable limits the same instrument shall be capable of dealing with engines of great or small power, allowing each to make its proper number of revolutions. As regards condition No. 1, the theory shows that, comparing two strictly similar but differently dimensioned instruments, their respective "moments of reaction" with the same speed of rotation in each, should be as the fifth powers of the respective dimensions. The writer has had a pair of similar instruments made, in which the turbine diameters are respectively 12 inches and 9·1 inch. Now $\left(\frac{12}{9\cdot1}\right)^5 = 4$, and accordingly the ratio of the moments of the two instruments at a given speed of turbine rotation should also have been 4. The ratio was in fact 3·86; but the small difference is referable to the circumstance that in the larger of the two instruments the internal surface was rather less smooth and the friction of the water consequently rather greater than the other. The data thus obtained not only verify the scale of comparison based on the 5th power of the dimension, but they also furnish a starting point by which to quantify the dimensions of the instrument which will be required to deal with any given horse-power, delivered with a certain number of revolutions per minute; and it thus appears that to command the measurement of 2,000 horse-power delivered with ninety revolutions per minute (a fairly typical speed for the power), an instrument will suffice in which the turbine is 5 feet in diameter, being in fact a duplicate turbine, or formed with two faces, with a double-sided casing to match. This two-faced arrangement, it may be added, while it supplies a double circumferential reaction with a given diameter, has the advantage of obliterating all mutual thrust on the working parts; the centrifugal forces of the double set of vortices pressing with equal intensity on the two internal opposite faces of the rigid casing. As regards condition No. 2, the theory suggests that, by contracting the internal waterways, that is to say, the passages through the cells in the turbine and the casing, and thus intercepting the free vortical rotation, all other things remaining the same, the moments of reaction due to a given speed of rotation could be greatly reduced.

The experiments with the models fully bore out this anticipation also, and proved that, by a very simple arrangement, the reaction with any given speed of turbine rotation can be reduced with a perfectly graduated progression in any required ratio down to 1-14th; the object being effected by advancing, from recesses in the casing abreast of the two opposite quadrants in each turbine, a lunette-shaped sliding shutter of thin metal, so fitted as to be carried forward (by a screw motion governed from the outside) along the divisional plane between the turbine cells and the casing cells. As the reaction of the instrument varies as the square of its speed of rotation, and the horse-power delivered through it consequently varies as the cube of the speed of rotation (that is to say, with a given setting of the shutters), and as, moreover, this law of variation is somewhat the same as that which the engine itself experiences when propelling the ship under natural conditions, it follows that the same setting of the shutters which suits a given engine when working with its highest speed and power will also approximately suit it when eased down to its lowest. It seems therefore that, alike as to the dimension of instrument suited to engines of very high power, and as to the adaptability of a given instrument to engines of greatly varied power, the requisite conditions are satisfactorily fulfilled. The discussion thus far has dealt only with the hydrodynamical reaction which the combination involves, and in a theoretical point of view this is sufficient; but as the practical application of the instrument plainly involves some ordinary mechanical reaction, due to friction in its working parts, it is well to point out that this, while it is of relatively small amount, is, in effect, wholly incorporated with the hydrodynamical reaction, and will thus be legitimately taken account of; in fact the frictional reaction on the screw-shaft will be precisely equalled by the action on the casing. It remains to be explained in detail how it is proposed to carry out the operation in dealing with any given ship. In the first place, to render it easy to connect the instrument with any given screw-shaft, the boss of the turbine must be bored out to a diameter considerably larger than that of the largest shaft to which it can have to be applied; and to fit it to a given shaft, an internal collar or "adapter" must be prepared, which will fit the interior of the turbine boss and the exterior of the screw shaft; and a proper key-way will be required for each fitting. The turbine thus mounted will "run true" on the screw shaft. The ship, before she leaves the dock for the trial of her machinery, will have the instrument mounted as described, in place of her screw. The casing will be provided with proper apertures, capable of being closed at will, to permit the egress of air and the ingress of water as the dock fills. The casing will thus be in a condition to receive the moment of rotation delivered by the screw and communicate it to the recording apparatus. If the "moment" to be recorded is regarded as a product of two factors, "force" and "leverage," of which (that the product may have its proper value at each instant) the one must vary inversely as the other, it is a question of convenience, whether the record shall take the shape of a large force delivered at short leverage, or *vice versa*; and it seems that the force-factor will prove inconveniently large, if taken account of at the circumference of the casing, and that it is desirable for several reasons that it should be obliged to develop itself at a leverage enlarged to many times the radius of the casing. The lever shown is a triangular combination, of which the diameter of the casing armed with proper projections forms the base, while the two sides, the upper one of which will be always in compression, the under one always in tension, are respectively formed of a spar and of wire rope. When the screw shaft is rotating, the compression and tension of the sides will be just 8·7 tons, and the downward force at the apex of the triangle will be 1·74 tons, or 3,900 lbs. The lever will be fixed to the casing before the dock is filled, and its construction is such that it can be "slewed" and "topped" under the ship's quarter so as to swing clear of the dock walls. The ship thus fitted will be brought alongside some quay wall of one of the floating basins, where the recording apparatus will have been already placed, projecting a few feet over the wall and carried on strong cantilevers or brackets; and she will be secured head and stern so as to prevent fore-and-aft movement, and will be boomed off to a proper distance from the apparatus.

The arrangement of the dynamometric apparatus presents no difficulty. In the form shown the downward pull delivered by the lever operates vertically on the middle of a flat horizontal steel spring, which is supported at both ends; and it is proposed so to proportion the spring that its maximum deflection shall be about 1½ inches. Different springs, however, would be required for engines if of widely different power. Immediately over the spring will stand a light framework, carrying two independent types of recording gear, both of which will, however, be actuated by the upper end of one and the same "feeler" or sliding vertical rod, which will convey to them the vertical elastication of the middle point of the spring, on which point its foot rests. In the one type the "feeler" will govern the position of an "integrating wheel," working on the face of a rotating disk, somewhat in the manner of Ashton and Storey's continuous steam indicator. The rotation of the disk will be made proportionate to that of the screw shaft, being communicated by a telescopic universal-jointed spindle, which takes its motion from the shaft by bevel gearing. When there is no stress on the lever, and no elastication of the spring, the integrating wheel will be adjusted to touch the disk at its centre, and thus will receive no rotation, and its count will be zero, whatever be the speed of rotation of the disk. When the spring is strained by the lever, the departure of the integrating wheel from the disk centre will be proportioned to the strain, and its rotation and its count will be the product of the strain and the rotation speed of the disk, or, in other words, the product of the moment impressed by the screw shaft on the casing and the speed of the screw shaft; that is the work done by the shaft. In the other type the duty of the "feeler" is to actuate the horizontal arm of a light bell crank, the vertical arm of which, by means of a long horizontal connecting rod, carries a pen freely along a horizontal straight line, while a sheet of continuous paper is independently moved under the pen across the line of its travel. The motion of the paper, like that of the rotating disk, will be derived from the rotation of the screw shaft. A stationary companion pen will trace on the paper a straight line as a record of that which the moving pen would trace

if the spring remained unstrained, and will thus serve as a zero of force. The moving pen will thus trace a diagram, the ordinate of which is at each instant a measure of the strain on the spring, and the area of which, like the count of the integrating wheel, is the product of the moment on the casing and the speed of the screw shaft; that is, as before, the work delivered by the screw shaft. The scales of both indications may be arranged at pleasure; in the one type by the speeding of the di k and the diameter of the counting wheel; in the other by the speeding of the paper and the proportion between the horizontal and vertical arms of the bell-crank; each when duly interpreted will be a record of the effective work delivered at the shaft end by the engine, revolution by revolution, and each will thus serve as a check upon the other. Each when connected with a time record, which may be done automatically, will be converted from a record of "work done" into a record of "horse power." For greater accuracy the light framework which carries the integrating apparatus, and serves as the gauge from which deflections of the spring are measured, will have its footing, not on the main frame, but on the spring itself, immediately over its points of support. The connections of the dynamometer spring, with its framework on the one hand, and with the lever on the other, are all arranged with mechanical details, such as to eliminate the effects of oblique stress, should any be introduced, by slight motions of the ship. The whole dynamometric apparatus would be covered by a light shed; it would be carried by a pair of strong balks, by which it would be "bracketed out" to a proper distance beyond the face of the quay wall; the inner ends of the balks would be loaded down by ballast. While a dynamometric trial is in progress, a series of indicator diagrams should be taken at short intervals of time; a comparison between the indicated H.P. as determined by the dynamometer would show how much power is wasted in the working of the machinery between the cylinders and the end of the screw shaft.

As to the development of heat, it will here be making its appearance in the body of a mass of water; and though the rapidity of the development will be so great that the whole contents of the casing would be quickly raised to boiling heat if the heat had no escape, yet there is a considerable refrigerating power always at work, since the whole casing is enveloped in cold water, and moreover there is no difficulty in creating a constant change of water within the casing sufficient to keep down the mean internal temperature to any limit which may be thought proper.

The advantages which would be derived from the system of submitting marine engines to dynamometric trial may be summarized briefly. It is certain that a very large but unmeasured amount of power is wasted in friction and otherwise, between the cylinders and the propeller; and that the amount probably differs both in respect of difference in type of engine, and in respect of goodness and construction of workmanship. (1) The speed attained by a given ship, driven by a given indicated horse-power, fails to measure discriminatively the merits of the ship. (2) No means exist of testing which type of engine delivers the largest proportion of the power which it indicates. (3) No test exists by which to measure concisely the specific constructional merit of this or that engine, or to determine the relative constructional merit of the engines supplied by different firms. The dynamometric test would remove at once each of these difficulties by substituting a final and real test for a collateral, and to a large extent a delusive one. For to rely exclusively on the test furnished by the indicator is almost equivalent to testing the power of a horse solely by the quantity of food he consumes and digests, or the efficiency of a boiler solely by the quantity of coal per hour it will legitimately consume on its firebars.

TESTS OF STATIONARY STEAM BOILERS AT THE CENTENNIAL.

THE report of Mr. E. M. Hugentobler, expert in charge of the steam boiler tests at the Centennial, to Mr. John S. Albert, Chief of the Bureau of Machinery, is now going through the press, and will cover about 200 octavo pages. It contains all the logs or records of observation, taken with much detail, and otherwise bears evidence of much painstaking in making the tests.

Through the courtesy of Mr. Albert, the *Franklin Journal* has been furnished with a copy of the proof-sheets of the report, from which the following is an extract:

The tables containing some of the more important results are compiled from more extended tables, of which there is a separate one for each boiler. In these latter there is also a column of the results of the "Capacity Test" of each boiler, but as the "Economy Test" is of more value to the steam user, only the last need be given here.

Fourteen boilers were tested, in the order named: the Wiegand, the Harrison, the Firmenich, the Rogers & Black, the Andrews, the Root, the Kelly, the Exeter, the Lowe, the Babcock & Wilcox, the Smith, the Galloway, the Anderson, and the Pierce boilers.

NATURE OF THE TESTS.

Two tests, each of eight hours' duration, were made of each boiler; the first with full natural draft and clean fires to determine the potential evaporation, the second with fires regulated to burn about three-fourths as much coal as before, or, in other words, to approximate average working conditions with a view of ascertaining the economical evaporation.

Calorimeter observations of the quality of the steam were taken at stated intervals during all the tests, and have been taken into account in computing the results of the several trials.

During all the trials a steam-pressure of 70 pounds was regularly maintained on the boilers by adjusting the stop-valves; a steam gauge was attached on the steam pipe just below the stop-valve, and a man was stationed at all times on top of the boiler to watch the gauge and regulate the valve accordingly.

Before beginning an experiment, steam was raised to 70 pounds, when the stop-valve was closed, fires hauled, and ash-pits cleaned. As soon as new fires could be established with weighed wood and coal, the water level was noted (with fire doors closed and fires burning), after which the stop-valve was opened; the time of opening the valve being recorded as the time of starting the test. After steaming for 8 hours, the stop-valve was closed and the water level again noted (with fire doors closed); the fires were then hauled and extinguished, and the ash pits cleaned out.

All the coal and kindling wood, estimated at its equivalent in coal, consumed for starting and maintaining new fires, were charged to the boiler, and all the water pumped into the boiler to maintain the level at the same height was credited to the boiler as evaporated, subject to corrections indicated by calorimeter, as explained below.

In the two tests of the Kelly boiler, the economy trial of the Exeter, and the economy trial of the Babcock & Wilcox boilers, the level at stopping was higher than at starting; and for those tests the amounts of water corresponding to the differences in level have been deducted from the amounts pumped into those boilers. In all other cases, however, the level at stopping was the same as at starting, or when lower a few strokes of the pump would bring it up to the required point, the water thus pumped being of course credited to the boiler as having been evaporated.

In all cases precautions were taken to trace all connections to the boiler on trial, to see that they were tight; and all blow-off pipes were disconnected, so as to detect any leak that might occur through the blow-off valves. In two or three instances slight leaks occurred, but all the water was collected and deducted from the amount fed into the boiler.

Before starting, the approximate amount of coal needed for the trial was weighed out of the coal bin and dumped in a separate pile on the floor, away from all other coals. From this pile coal was taken in barrows as required for running the test, and the weight of each barrow load noted. This plan of keeping two separate accounts of the coal removed all chance of error in the amount of coal actually consumed, as at the close of each experiment the two accounts were balanced, and any error would have been detected at once. The second coal account has been taken as the basis for calculating the evaporation, adding to it, of course, the equivalent of the kindling wood, which was taken at the rate of 0·40 pound of coal per pound of wood.

Upon completing a trial, fires were hauled and extinguished as rapidly as possible, the grates and ash pits carefully cleaned, and all the coal, ashes and clinkers hauled from under the boiler were sifted. The coal was carefully picked by hand and weighed separately. This amount of coal deducted from the amount of coal fired on the grates gives the amount of coal actually consumed. By deducting from the latter the amount of refuse (ashes and clinkers), the amount of combustible consumed was determined.

The feed water measuring apparatus consisted of two metallic tanks placed on separate platform scales, with provision for filling from the hydrant. A Blake double-plunger feed-pump, supplied with steam from the boiler on trial, was placed between the tanks, and its suction-pipe was provided with a rubber hose, whereby the pump could be made to take water at will from either tank. This pump was used on all the trials, and whenever it was attached to a new boiler, precaution was taken to see that the feed-pipe was tight, and that all other connections of the boiler to other pumps or injectors were broken off.

After filling a tank with water from the hydrant, its gross weight was noted, and after it had been pumped out almost dry, the suction-hose of the pump was shifted to tank No. 2 (previously filled and weighed), and the gross tare of tank No. 1 was taken; the difference between the gross initial weight and the gross tare being the net weight of water pumped into the boiler. Tank No. 1 was then refilled and its gross weight again noted, when it stood ready to supply the pump as soon as tank No. 2 should be emptied.

The temperature of the feed-water was observed twice in each of the tanks. In the logs will be found the gross weights and gross tares of the tank, together with the times at which hose was shifted, and the heights of water in the boiler at those times, also the temperatures of feed-water. The measurements of the feed-water and the running of the pump were intrusted to one assistant.

Another assistant had charge of the coal accounts, and

NAME OF BOILER.	Average steam pressure in boiler, above atmosphere.	Average temperature of steam.	Average temperature of uptake.	Average temperature of feed water.	Average amount of coal consumed per sq. foot of grate per hour.	Number of pounds of water actually evaporated per pound of coal.	Number of pounds of water actually evaporated per pound of combustible.	Average actual amount of water evaporated per hour. Pounds.	Number of pounds of water actually evaporated per sq. foot of heating surface, per hour.	Percentage of moisture in steam	Number of degrees superheated (steam).	Number of lbs. of saturated steam evaporated at 70 lbs. from 212° equivalent to total heat units derived from the fuel.			Rating of boiler on the basis of 12½ sq. feet of heating surface per horse-power.	Rating of boiler on the basis of 30 lbs. of water actually evaporated per horse-power, per hour.
												Per pound of coal.	Per pound of combustible.	Per sq. ft. of heating surface per hr.		
Wiegand, . . .	70·029	313·17	523·81	70·80	12·32	8·219	9·097	4255·36	3·14	......	13·40	9·463	10·461	3·618	108·40	141·85
Harrison, . . .	70·03	310·76	517·50	71·16	12·30	8·036	8·785	2285 73	2·532	1·11	....	9·167	10·022	2·894	72·06	76·19
Firmenich, . .	70·059	356·17	415·50	68·95	11·79	8·927	9·956	1654·20	1·533	......	26·70	10·340	11·530	1·775	86·31	55·14
Rogers & Black,	70·30	309·76	571·75	67·11	....	7·266	8·059	1320·57	3·30	2·68	....	8·397	9·313	3·810	31·98	44·019
Andrews, . . .	70·059	328·47	419·60	65·44	8·05	7·985	8·904	1183·74	2·19	......	52·59	9·428	10·513	2·590	43·20	39·46
Root, ...	69·94	312·50	393·33	64·59	9·09	8·889	9·930	3393·33	2·217	......	23·16	10·352	11·565	2·485	127·20	113·11
Kelly, ...	69·95	310·00	....	66·95	10 82	7·858	8·636	2338·56	3·532	5·97	....	9·189	10·099	4·131	52·96	7·795
Exeter, . . .	70·00	308·00	429·94	68·93	9·35	7·276	8·213	2041·70	1·338	4·63	....	8·643	9·756	1·589	122·04	68·06
Lowe, ...	70·00	309·00	332·29	66·44	6·805	8·758	9·873	1341·18	1·731	......	1·05	10·190	11·489	2·014	61·97	44·71
Babcock & Wilcox	70·00	389·06	295·82	63·98	9·77	8·812	8·908	3919·81	2·33	3·24	....	10·211	11·489	2·701	134·40	130·66
Smith,[1] . . .	....	....	....	....	....	....	....	....	....	......	....	....	....	....	....	....
Galloway, . .	70·06	310·06	303·00	55·95	8·87	8·514	9·580	2945·71	3·026	0·22	....	9·942	11·187	3·533	77·88	98·19
Galloway,[2] . .	70·12	310·06	324·62	55·12	7·269	9·182	10·069	2603·02	2·673	0·57	....	10·689	11·720	3·113	77·88	86·77
Anderson, . .	70·00	322·75	417·00	54·00	9·747	7·918	8·727	2778·81	2·448	......	14·88	9·305	10·255	2·877	90·08	92·63
Pierce, . . .	70·00	312·94	373·82	53·20	7·99	7·419	8·336	1484·61	7·406	5·53	....	8·738	9·818	8·714	16·03	39·48

[1] No Table of Results of the Smith Boiler was furnished.

[2] This test was made with Bituminous Coal.

STATIONARY STEAM BOILERS AT THE CENTENNIAL. RESULTS OF THE TESTS FOR ECONOMY.

also took half-hourly observations of the temperatures of the outside air, of the fire-room, steam, pyrometer, water level, and steam-pressure. This latter observation was taken from the gauge mentioned above, attached just below the stop-valve. A recording gauge was also attached to the boiler and served to detect any negligence on the part of the man stationed on top of the boiler to regulate pressure. The barometric pressures given in the logs were not observed in the fire room. Necessary data were kindly furnished by the Signal Station, U. S. A., and proper corrections were made for level and temperature.

The records of the temperature of steam, as shown in the logs and given by a mercury thermometer, are undoubtedly too low. I found that in certain cases, when a draft would blow over the boiler, the simple fact of covering the stem of the thermometer would cause the mercury to rise 10 or 15 degrees. However, it may be seen that, although the temperatures shown by thermometer fall short of the temperatures indicated by calorimeter, the variations in both sets of records correspond.

COAL AND FIRING.

The coal used in all the trials was anthracite coal from the Lea Colliery, Wilkesbarre, Pennsylvania, and was the same as was supplied regularly to the Bureau of Machinery; it was nearly all uniform in size; in quality it varied somewhat, as shown in the following table:

PERCENTAGE OF REFUSE FROM COAL.

	Capacity Test.	Economy Test.		Capacity Test.	Economy Test.
Wiegand......	8·487	9·537	Exeter.......	9·265	11·405
Harrison.....	8·369	8·526	Lowe.......	10·640	11·286
Firmenich.....	8·625	10·338	Babcock &		
Rogers & Black	8·373	9·835	Wilcox....	7·845	10·237
Andrews......	9·428	10·319	Galloway....	11·055	11·128
Root......	9·67	10·48	Anderson....	8·684	9·261
Kelly.........	8·67	9·01	Pierce.......	8·401	11·600

The coal for the trials was by no means selected or picked, but taken as it came, the prevailing object throughout the test being to get at average working conditions.

The two regular trials for economy and capacity were repeated on the Galloway boiler with bituminous coal, that boiler being proportioned for that kind of fuel. The coal used was George's Creek bituminous coal; it was of very fair quality, but necessitated constant attention to the fires, as it ran and caked very freely on the grates.

The firing was left entirely to the judgment of the exhibitors and their men.

CALORIMETRIC OBSERVATIONS.

Of the several methods for ascertaining the amount of water carried over with steam from a boiler, the calorimetric investigation of the quality of steam, first applied in 1859 by Prof. G. A. Hirn, is the most simple, the most direct, and the most accurate. At the same time it is so practical that it should certainly come into general use. The principle of this method is to condense a certain weight of steam in a given weight of water contained in a vessel, the temperature of which is thereby increased; the number of heat units imparted to the water (its weight multiplied by the increase in temperature) represents the amount of heat liberated by the steam in condensing, and then cooling down to the temperature at which both the water originally in the tank and that formed by the condensed steam stand at the end of the operation.

In these tests the calorimeter consisted of a plain wooden barrel, provided with a suitable stirring apparatus, and placed on a platform scale; a drain pipe was attached to the bottom of the barrel, and provision was made for filling the barrel with water from the hydrant. Into a vertical portion of the steam-pipe of the boiler, and close to and below the stop-valve, was screwed a short horizontal piece of ¾-inch pipe, which was screwed in until it touched the opposite side of the steam pipe. A row of small holes was drilled on one side of the ¾-inch nipple, and in attaching it care was taken that the holes should be turned downward, the object of this contrivance being to catch steam from all the portions of the ascending stream in the steam-pipe. To the ¾ inch nipple was attached a ¾-inch pipe, felted throughout its length, and running to within a couple of feet of the calorimeter barrel. At the end of this pipe was attached a ¾-inch globe valve, and beyond that was fastened a 1-inch hose about 5 feet long. The observations were taken every twenty minutes in the following manner: The barrel was filled with water from the hydrant, and the gross weight and the temperature were noted. The globe valve on the ¾-inch steam-pipe was opened just enough to puff out all water which might have collected in the pipe; then the end of the hose was dipped in the water in the barrel, and the globe valve opened wide. At the same time a signal was given with a gong for the man on top of the boiler to note the steam pressure. The water was agitated in the calorimeter barrel so as to insure a thorough distribution of the heat throughout the mass of water. When the temperature in the barrel had been raised sufficiently, the globe valve was closed; the signal was repeated for the man on top of the boiler to note the steam pressure again, and the temperature of the water in the barrel was carefully observed; then, after taking the hose out of the water, and letting drip from it into the barrel all water which might have been lifted with it, the final gross weight was taken, the increase in weight representing the steam (with water primed, if any) brought into the barrel.

During the progress of a calorimetric observation the man on the top of the boiler was not allowed to touch the stop-valve, in order to prevent changing the conditions of steam.

The duration of the calorimetric experiments varied somewhat. It was attempted as a rule to reach a final temperature in the barrel as many degrees above the temperature of the surrounding atmosphere as the initial temperature was below, the object being to compensate for loss and absorption of heat through the surface.

All things being equal, the duration of the experiment was governed by the quality of steam, as the hotter the steam the less time it would take to heat the contents of the barrel. This may seem useless to mention, still it showed the sensitiveness of the apparatus.

The calorimeter data are given in the logs. The weight of the barrel is also given; it is the mean of two weighings at the beginning and the end of the trial. An allowance has been made, in computing the results, for the iron stirring apparatus in the barrel, which has to be heated every time, with the water. The weight of the stirrer, multiplied by the specific heat of iron, has been added in all cases to the net amount of water heated.

A NEW FORM OF MARINE BOILER.

In a paper read before the North of England Institute of Mining and Mechanical Engineers, at Newcastle-upon-Tyne, on the above subject, by Mr. John Shaw, we find the following statement made, viz., that the evaporative power of the boiler was equal to 13lbs. of water per pound of coal consumed. We need hardly give an illustration of the boiler referred to, simply stating that it is an ordinary single-ended boiler (four in the set), two set back to back in two sets, having the combustion chambers removed and this portion of the boiler built up with fire-brick instead of in the ordinary manner. The particulars of the machinery are given as one high-pressure cylinder of 35 inches diameter, and one low-pressure cylinder of 70 inches diameter, the stroke of each being 3 feet 6 inches, making 58 strokes per minute; the steam being cut off at 32 inches of the stroke of the high-pressure cylinder. The result above stated being shown by the following equation:

$$\frac{\overset{\text{Ins.}}{62} \times \overset{\text{Revn.}}{58} \times \overset{\text{Area.}}{962} \times \overset{\text{Min.}}{60} \times \cdot036}{\underset{\text{Steam to water.}}{310} \times \underset{\text{lbs. of coal.}}{1792}} = 13\text{lb. of water.}$$

per pound of coal per hour. The working pressure being 80 lbs. per square inch above the atmospheric pressure.

The consumption of coal is stated to be 1792 lbs. per hour, and the indicated horse-power as 1057 horses, or $\frac{1792}{1057} = 1\cdot7$ pounds per indicated horse-power per hour. The cylinders being 35 and 70 inches respectively, it will readily be seen that the ratio of capacity is as four to one, and the steam being cut off when the piston of the high-pressure engine has travelled 32 inches, we have $\frac{42}{32} \times 4 = 5\cdot25$, the number of times the steam will be expanded, if we neglect capacity of passage and receiver, the capacity of passages in the high-pressure cylinder compensating in a manner for this.

If we now take, for sake of comparison, a single cylinder engine of 35 inches diameter of cylinder, and of four times the stroke (or 14 feet), making the same number of revolutions (58), with a working pressure of 80lbs. above the atmosphere, the steam cut off at 32 inches from the commencement of the stroke; we shall have for the theoretical horse-power to be obtained from such an engine:—mean pressure due to expansion $5\frac{1}{4}$ times $= 80 + 15 \times \cdot5 = 47\cdot5$ per square inch and

$$\frac{\overset{\text{Area.}}{962} \times \overset{\text{Lbs.}}{47\cdot5} \times \overset{\text{Ft.}}{28} \times \overset{\text{Revs.}}{58}}{33000} = 2248 \text{ horse-power}$$

If we now suppose the engine to be of one cylinder, 70 inches diameter and 3 feet 6-inch stroke, making the same number of revolutions (58) with the same ratio of expansions ($5\frac{1}{4}$ times) or steam cut off at 8 inches from the commencement of the stroke, we shall find that the mean pressure is the same in this case as in the last considered, viz., 47·5 lbs., and

$$\frac{\overset{\text{Lbs.}}{47\cdot5} \times \overset{\text{Area.}}{3848} \times \overset{\text{Ft.}}{7} \times 58}{33000} = 2248 \text{ horse-power.}$$

(This is the same power as we obtained by supposing the high-pressure cylinder lengthened out in stroke in the same proportion as the ratio of the cylinders in capacity are to each other.)

Having now obtained the theoretical value of the engine (2248 indicated horse-power), let us examine what are the actual results obtained. The indicated h.-p. is given at 1057 horses, testing by the first method, or by high-pressure cylinder, we shall have

$$\frac{\overset{\text{I. H. P.}}{1057} \times 33000}{\underset{\text{Area}}{962} \times \underset{\text{Feet}}{28} \times \underset{\text{Rev.}}{58}} = 22\cdot4 \text{ lbs. mean pressure (instead of } 47\cdot5\text{lbs).}$$

If we now take the second method, and test by the large cylinder (or low pressure), we shall have

$$\frac{\overset{\text{I. H. P.}}{1057} \times 33000}{\underset{\text{Area.}}{3848} \times \underset{\text{Feet.}}{7} \times 58} = 22\cdot4 \text{ lbs., the same as before.}$$

It will readily be seen, by reference to an expansion table, that a mean pressure, as realized when working with steam at 80 lbs. per square inch above the atmosphere, is only equivalent to a supply of steam to the high-pressure cylinder of such an amount as shall give out a ratio of expansion equal to 16 times, or

$$\frac{\overset{\text{Ins.}}{42} \times 4}{16} = 10\cdot5 \text{ inches,}$$

the portion of steam admitted, which would give out the theoretical horse-power obtained by the indicator diagram.

The indicated horse-power is therefore only

$$\frac{1057 \times 100}{2248} = 47 \text{ per cent.}$$

of that theoretically due to a single engine of either of the respective diameters of cylinder, viz. 35 inches and 14 feet stroke, or a 70 inch and 3 feet 6 inch stroke, as before shown.

We are, therefore, of opinion that sufficient care has not been exercised in ascertaining the quantity of water said to be evaporated, for if (which we doubt) the boilers are so effective, then the loss in the engines is very heavy. We have laid this before our readers with a view to draw their attention to the very low effective power obtained from the compound engine as compared with the theoretical power. There is no engine that is a greater waster of power unless carefully designed and worked in accordance with the laws regulating compound engines, and which laws have been so well pointed out by Mr. William Pole, of London, in a paper on compound engines, read before the Institute of Mechanical Engineers at Birmingham, in 1863, and published in the proceedings of that Society for that year. As many of our readers may not be able to get sight of a copy of that paper, we may here state that Mr. Pole satisfactorily demonstrates that, to attain the advantage which may be obtained by use of the compound engine, one law must be always studied, viz., that the actual ratio of expansion in the high-pressure cylinder must always be the same as the ratio of capacity of one cylinder to the other, viz., if the cylinders are as 3 to 1, then the expansion of steam in the high-pressure cylinder must be 3 times, if 4, then 4 times, and so on.

The neglect of this will, in our opinion, account for much of the disappointment which has been caused by want of success in many cases of compounding engines.—*Marine Engineering News.*

MECHANICAL APPLIANCES USED IN THE CONSTRUCTION OF THE HEADING UNDER THE SEVERN, FOR THE SEVERN TUNNEL RAILWAY.*

THE subject was arranged under the following heads: Soundings by machine; sinking of first shaft; driving the heading by hand, by the McKean machine, and by the writer's machine; details of the rock-drilling machine in use; details of rock-drill carriage; details of air pump, and method of cooling; details of the pumping machinery.

Soundings.—These are taken by the aid of a machine which was shown. It consists of a light drum, round which the brass sounding wire was coiled; a worm on the same shaft gearing into a worm wheel, and an adjustable index hand and plate. The lead used was 12 lb. weight. This machine enabled two soundings per minute to be taken in 60 feet of water. The plan followed was to sound on parallel lines north and south of the parliamentary center line, at intervals of 30 feet apart. After about twenty of these lines had been sounded and plotted, a final line was decided on as the center line of the tunnel; and along this soundings were again taken more numerous than before, and so well did these soundings agree that two would often plot on the same spot although taken at different times.

Sinking of First Shaft.—As soon as the final center line for the tunnel was fixed, the position of the shaft was marked out, and sinking was commenced by hand through sand, sandstone, and marl, down to 45 feet deep, at which depth the hand-pump, skips, etc., failed to keep the water under. As a temporary measure, one of Tangye's special pumps was put to work on the shaft, and by its aid the sinking was carried 25 feet further, when it got overpowered. A bucket-lift, on the Cornish plan, was then erected, which kept the water under at four strokes per minute. As the shaft when down, a plunger-lift was coupled on the same engine, working in a tank, into which the same bucket-lift raised the water. With the aid of these lifts the shaft was sunk to the required depth of 200 feet, having passed through top soil, sand, sandstone, marl, conglomerate, pennant, clay shales, coal shales, millstone grit, limestone boulders and clay, and into ironstone. When down to the proper depth another similar plunger-pump was erected at the bottom of the shaft, and the one with which the shaft had been sunk was also fixed at the bottom; so that there were two plunger-lifts fixed for draining the heading. Two suitable cages were now erected in the shaft, with wood guides, and were provided with catching-gear. These cages were suspended by ⅞ inch round steel wire ropes, both ropes working on the same drum, but wound on in opposite directions. The drum was 6 feet diameter, and was geared 1 to 4 to a pair of horizontal engines with 10 inch by 14 inch cylinders fitted with reversing gear, and with two brakes on the drum direct and the other on the crank-shaft of the engine.

Driving the Heading.—The heading was driven by hand labor, and the progress that could be made was not more than one foot per 24 hours. The McKean rock drills were then put at work, and for the next month the progress averaged two feet per 24 hours. These machines worked from January, 1875, until the November following, when they were entirely worn out; the average rate attained was 6 feet per 24 hours, In November, 1875, the author's improved rock-drilling machines were put to work, and in driving by their aid till the end of January, 1876, the average speed in the same pennant rock had risen to 8 feet per 24 hours. This has since been much exceeded: 20 yards in 6 days, or at the rate of 10 feet per day, has been driven in solid rock. The average speed in the same rock is now rather more than 9 feet per 24 hours.

Rock Drilling Machine.—This rock drill differs from most rock drilling machines in being made strong and heavy, and having a very efficient system of rotating and method of holding the drill. The latter feature is quite new, as far as the writer is aware; its extreme simplicity, and the entire absence of any loose parts, must commend it to practical men, whilst its holding power is ample. It is also self-centering. The following is an example of the time occupied in boring by this machine for blasting, the work being done 4,432 feet, or more than three-quarters of a mile, from the bottom of the shaft, which is 200 feet deep. The rock drill carriage was moved forward from a siding at 11:30 A.M., and taken to the face, coupled up, and fixed; at 11:41 A.M., the machines commenced boring, and in 1 hour and 6 minutes 20 holes were finished, averaging 2 feet deep each; the rock drill carriage was then uncoupled and run back to the siding, and the holes were charged with dynamite ready for firing at 1 P.M.; total time occupied in boring and charging, 1 hour and 19 minutes. Two of the rock drilling machines were used, one on each side of the carriage; and the left hand machine was worked by a man whose experience of machine drilling only extended over 12 days. The following are the particulars of a few of the holes in the order in which they were bored on this occasion by this machine and man:

No. of hole.	Boring Commenced.		Time occupied in changing drill.	Boring finished.		Total Time.*	Depth Bored.	
							Total.	Per Min.*
No.	H.	M.	Sec.	H.	M.	Min.	Inch.	Inch.
1	11	41	20	11	44	3	18	6·0
2	11	46	20	11	51	5	26	5·2
3	11	52	50	11	59	7	28	4·0
4	12	1	15	12	5	4	24	6·0
5	12	6	55	12	10½	4½	31	6·9
6	12	15	35	12	19½	4½	24	5·3

* Including the time occupied in changing the drill.

These six and the remaining four of the ten holes were all bored by two drills; it is found, as a rule, that four drills put down 40 feet depth of hole, or each drill bores 10 feet before wanting sharpening, which is done in the forge, no fitting or grinding being required. The holes are all bored truly cylindrical, proving the perfect rotating and boring power of these rock drills. The rock drilling machine consists of a cylinder, with piston and rod and valve gear, mounted on a slide bed. The cylinder has no loose covers or split glands, which in some machines have proved a source of great trouble and expense. The piston and piston rod are made in one piece of steel. The piston has two rings of steel, and the rear end of the rod, 1½ inches diameter, is cut with spiral grooves, making one complete turn in 32 inches; this fits into a long cylindrical nut, on the center of which is formed solid a ratchet-wheel, 3¼ inches diameter, having 28 teeth. Into these teeth a pawl engages, to prevent the rotation of the drill and piston rod in more than one direction. When the

* A paper lately read before the Institution of Mechanical Engineers, Bristol, Eng., by John J. Geach.

piston rod is making its full stroke, the pawl slips over three teeth per stroke and holds them; the rotation of the drill and piston rod is effected in the backward stroke, and the forward blow takes a straight direction. The front end of the piston rod is $2\frac{1}{4}$ inches diameter in front, and coned to $1\frac{1}{2}$ inches at 4 inches back. A keyway, $1\frac{1}{2}$ inches by $\frac{1}{2}$ inch, is cut through the cone, for the purpose of forcing out the drill when a longer one is required. Over the end of the piston rod, in which the coned hole is bored, a steel hoop $\frac{3}{8}$ inch thick is shrunk, to prevent the coned end of the drill from bursting the end of the piston rod, and to give a certain amount of elastic clip. The drill is securely and truly held, and has never been known to fail in any degree during months of continual work. The valve gear consists of two pistons on one rod sliding in a cylinder; the air is taken in between these pistons, and by their motion is alternately admitted to and let out of the ends of the drill cylinder. The ports are small, 1 inch long, $\frac{5}{8}$ inch wide, and $\frac{1}{2}$ inch deep, and are placed $\frac{1}{8}$ inch short of the cylinder ends to form a cushion. The valve pistons have for packing C rings with a spiral spring behind, one in each piston; the solid part of the piston is toward the port, so that there is no risk of the ring getting into the port. The valve is driven by a ball tappet on the piston rod, through a quadrant mounted on a pin. The method of feeding the drill forward as it bores the hole is by a $1\frac{1}{2}$ inch feed screw, rotated by hand, and experience has shown hand feed to be the simplest. On paper, automatic gear looks best; but when machines come to work, as they have to do, under varying conditions and hard usage, simplicity is of the greatest importance. Comparisons of hand with automatic gear are often based on the work of a self-acting lathe or other shaping machine, which is not a fair comparison. In the one case the tool is acting on a material which is known and has been seen, and in the other the working is in the dark to a great extent, owing to the presence in the rock of joints and backs and layers of soft material. The machine bed is held to the clamp on the crossbar of the rock drill carriage by the clip bolts and set screws; and the crossbar is again clamped to the vertical face of the rock drill carriage. The drills in use vary from 2 feet 6 inches to 6 feet 6 inches length, worked in sets, so that the right and the left hand machine would have, to a certain extent, drills of equal lengths. Long and short drills work well, and in ordinary use will, without sharpening, drill through 10 feet of rock each. At the end of this depth of work the drill is still sharp enough to bore 20 feet further, but in this rock it is reduced in diameter nearly $\frac{1}{2}$ inch, so that it is necessary to have the drill again jumped up, that the borehole may be large enough for the dynamite cartridges to pass freely to the bottom of it. The drills used are all of a cross section on the point, and the cutting or abrading edge is sharpened in the forge and roughly filed up when hot, so that the leading angle is about 75°. The whole of the castings for these machines are of phosphor bronze, the bed of wrought iron, and the remaining parts of steel.

Carriage.—The carriage for the machine was designed specially for this work; it has done good service and is now equal to new, the only wearing parts being the corner supporting screws and the roof screw and bearing wheels. This carriage runs on the same gauge of 21 inches as the trolleys, and when not in use is run back into the first passing place or turn-out. It is all in cast iron except the screws, nuts, and axles, and was made at Swindon from the writer's drawings. The base plate of the carriage is 4 feet 6 inches long, 2 feet 6 inches broad, and 1 inch thick, flanged all round. The wheels are small, to keep them under the base plate and the carriage low down; and are 6 inches in diameter, of chilled cast iron. They rest on two heavy steel rails, 8 feet long, held together by 3 cross stud bolts and nuts which are advanced as the heading progresses; and matching pieces of rail are inserted behind until there is length enough to insert an ordinary rail, when the same process is again repeated. The heavy framed steel rails are kept in front as a foundation for the carriage to rest on. On the base plate is firmly bolted an A frame, with the front limb vertical; and through the head of it a strong screw works, $2\frac{1}{2}$ inches diameter, so as to jack the stand firmly on its bearing screws, which are first run down on the rails to relieve the wheels and axles. The vertical face of the A frame is planed, and has a section of 2 inches by 6 inches; and on it is a clamp, which holds the tube carrying the rock drill. This clamp clips the vertical face of the carriage and also the crossbar, and by slacking the back nuts the clamp and crossbar can be raised or lowered; and the front nuts similarly hold the cross tube. Only two rock-drilling machines are worked on this bar at once, which bore 20 holes in 1 hour and 7 minutes. On the rear leg of the A frame are air and water distributors, one on each side, to which are connected the air and water pipes by hose and couplings; and they are provided with outlet cocks, one for air to each machine, and one for water to each hole. The air is brought forward by 2 inch wrought iron pipes screwed together, and the water by $1\frac{1}{2}$ inch and 1 inch pipes. The air pressure is 60 lb. per square inch, and the water has a head now of 180 feet. A powerful jet of water, playing in the hole as it is bored, is found of the greatest service, especially in upward holes. The water is spurted into the boreholes through nozzles $\frac{1}{4}$ inch diameter.

Air Compressors or Pumps.—At first the air was pumped into the receiver by a pair of inverted single-acting cylinders, 12 inches by 15 inches, a trunk closed with a valve on the upper end worked on each cylinder, driven by connecting rods from two opposite cranks on one shaft, on which a pulley 5 feet diameter and a fly wheel were fixed. The pulley was counterbalanced, but it was soon found that the belt, although 8 inches broad, and double, would not stand the work; consequently a vertical engine, with $9\frac{1}{2}$ inch by 18 inch cylinder, was coupled on at right angles to the cranks of the air pump. This worked fairly well, but the delivery and also the inlet valve gave much trouble by breaking. Another air pump was designed for the purpose. It was made intentionally larger than the present requirements, and now supplies enough air when driven at slow speed. The air and steam cylinders are each 13 inches by 18 inches, mounted vertical on two similar standards, and coupled to the crank shaft at right angles to each other. They are so made that, if anything goes wrong with the valves at either end of the air cylinder, the defective cover and valves can be taken off, and the cylinder worked single-acting. There are two inlet openings for air, which is intended to be forced into the cylinder by a fan, so as always to charge it fully for each stroke; also two outlets coupled to a 4 inch pipe leading to the air receiver. This receiver is 28 feet long and 5 feet diameter, formerly an egg-ended boiler; it is usually kept nearly half full of water to cool the air during compression in the cylinder, as afterwards explained. The receiver is fitted with water gauge, pressure gauge, and safety valves; and a 2 inch pipe is coupled to it, leading down the shaft and to the face of the heading. The inlet and outlet valves are of brass, and have been found to work well. The air cylinder is jacketed for water to keep it cool; but the jets of water that are injected keep the cylinder, etc., cool enough without the use of the jacket. At each end of the cylinder a small ball clack is screwed into the casting; and these clacks are coupled to the lower part of the air receiver by a copper pipe, $\frac{3}{4}$ inch bore. These small clacks are so arranged that when the pressure in the air receiver is greater than that in the cylinder, a jet of water is injected, and thus the air is kept sufficiently cool. The air and water are carried on together to the air receiver, where the air parts with nearly all its water. The receiver is filled half way up every week, and this quantity of water does not lower more than 6 inches during the 6 days' work, the water being continually circulated, heated, and cooled, through the air cylinder and receiver.

Pumping Machinery.—At first a Tangye special pump was used; but this soon got overpowered and worn out, and the grit from the rock cut the pistons and cylinders so badly that it could not do the work required. The pump by which the shaft was sunk is 15 inches diameter with 7 feet stroke, and is driven through a ⊥ bob with balance boxes off the crank pin of a 9 feet spur wheel, which is geared to a pinion on the crank shaft of a horizontal engine in the proportion of 1 to 5. The cylinder of the engine is 18 inches by 26 inches, worked with 60 to 80 lbs. steam. All the parts are massive, on the locomotive type, and it is fitted with reversing gear. The ordinary speed of the pump is 10 to 12 strokes per minute. The wood main rods or the pumps are 11 inches square, and as the shaft went down the bucket lift was worked off one side of the rod, and the plunger lift, 15 inches diameter, off the other side. After the shaft was down, this plunger was fitted to the lower end of the main rod, thus doing away with the bucket lift and all its wear and tear, and working direct. Another similar engine and pump were then put up as a duplicate, and to be ready to help if required. These engines were supplied with steam by two multitubular boilers, 20 feet long and 5 feet diameter, assisted by a broad gauge locomotive boiler. A 40 inch Cornish beam engine, 10 feet stroke, was then added, with an 18 inch plunger lift, 9 feet stroke; this engine is very economical, and works steadily in a very satisfactory manner. As the water was still on the increase, from 80,000 to 100,000 gallons per hour, another plunger lift, 15 inches in diameter, and with the same stroke, was added. With this extra load a steam pressure of 45 lb. per square inch was required, cutting off at about $\frac{1}{4}$ stroke, and a vacuum of 26 to 28 inches. This engine has 3 Cornish boilers, 5 feet 6 inches diameter, and 24 feet long. A new shaft is now being sunk for permanent pumping purposes: and to do this quickly, a cross drift was driven from the present heading, and a 10 inch hole was bored down to it so as to unwater the ground. This new shaft is now down 150 feet out of 200 feet total; the pump was sunk out in the dry before the 10 inch borehole was down and the girders for carrying the pump work built in place. The engine is a direct acting one, with 50 inch cylinder and 10 feet stroke, and the pump is 26 inches in diameter and 10 feet stroke, and is worked through wrought iron main rods of 5 inches diameter. All the work in this pit is arranged for two such engines and pumps. The valves in this and the other two pumps are Harvey's four beat valves; they work with the least lift, and all shocks are avoided. The 50 inch engine has 3 boilers, 5 feet 9 inches in diameter and 28 feet long, with 3 feet 6 inches flues, each with 10 Galloway cross tubes; the working pressure will be 50 lb. per square inch.

Mr. Geach added that the machine would now bore 12 inches a minute; he hoped the members would see it at work on Tuesday, but they must remember it was more difficult to bore when working under water on the surface.

Mr. Froude expressed the pleasure he had derived from the paper, and asked what was the quality of the steel the drills were made of, and if they were tempered quite hard? To which Mr. Geach replied that they were made of the best cast steel that could be obtained, and, after being hardened, were let down to straw color.

Mr. Morgan asked the dimensions of the two cylinders and valves; and inquired if the author had tried blasting the holes by electricity; and another member asked the number of strokes a minute that produced the best effect.

Mr. Cowper asked what quantity of air was used, and at what pressure.

Mr. Geach, in reply, said that the cylinders were 13 by 18 inches, and that the pressure rose to 60 or 70 lb. per square inch. He had tried electric firing, but only with poor results; he had succeeded in firing all the holes at once, but had not been able to bring away so much rock as with the present system of hand firing. The number of strokes varied, but 90 a minute would be about the average. The interior of the cylinder, like Mr. Webb's valves, kept perfectly true, owing to the partial rotation of the piston. The air pumps, when new, supplied sufficient air for both drills; but that would depend on their state of repair. It was well known that an air cylinder was more subject to wear than a steam cylinder, on account of the dirt being drawn in. Like most others, his rock drill made a partial turn during the back stroke.

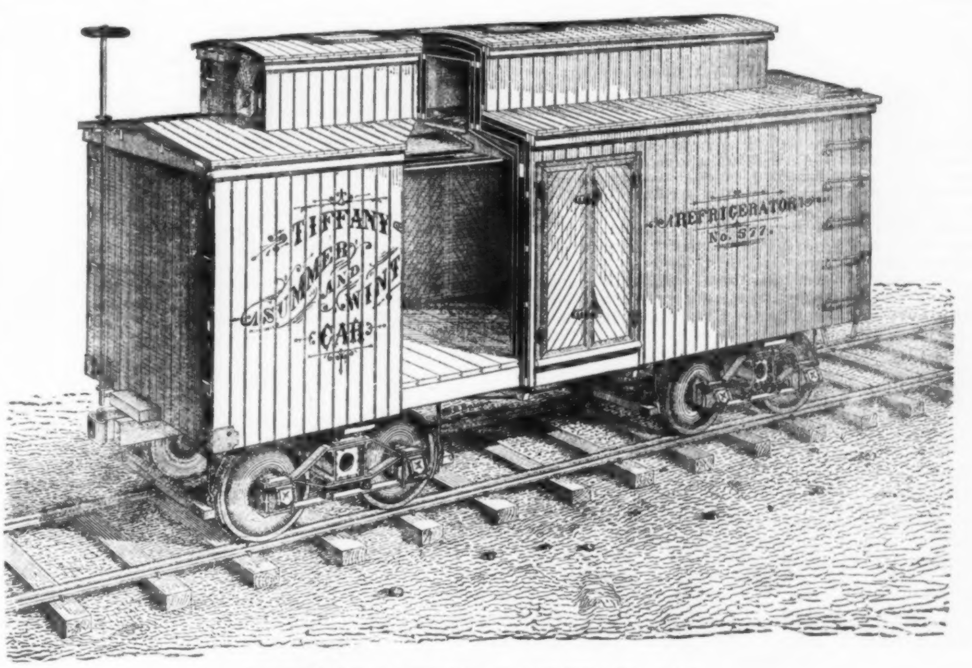
REFRIGERATING RAILWAY CAR.

IN the construction of the Tiffany refrigerating cars, chill rooms, etc., for the transportation and preservation of dressed meat, poultry, game, etc., there are three very important principles to be observed; and so far as art can devise the means of combining and applying these principles, will it be successful in the construction of cars and chill rooms fit to trusted.

1. The temperature of such rooms should be reduced no lower than is necessary for the preservation of articles stored therein. An article which is safely kept at a temperature of 45° Fahrenheit will be injured in its keeping qualities if it is subjected to a much lower temperature, say to 36° or 38°, and will soon go to decay when exposed to the common summer temperature.

2. The ice employed to give the desired temperature should be so placed as, by the force of gravitation only, to immerse the articles to be preserved in the chill air. Gravitation is ever present, and will operate to give the necessary temperature while ice is maintained in sufficient quantities in its proper place, which is above the chill room, with means of interchange of temperature established between the rooms. Where artificial means are resorted to in the place of gravitation to do the necessary work, like fanning, blowing, etc., any accident suspending the operation of the mechanical means will defeat the purpose for which the means are employed. Consequently, the only absolutely reliable place to store the chilling material is above the material to be preserved, with the means of interchange of temperature between them.

3. As far as possible, a moderate ventilation, supplying fresh, clean air, should be provided for the articles to be preserved. Every person almost has observed the value of



REFRIGERATING RAILWAY CAR.

live or *moving air* in the preservation of fresh meat and other similar articles, as compared with dead or confined air. Even timber will perish in a short time unless supplied with *live air*. At or near the temperature of freezing, meat and other like articles may be kept a long time without going to decay; but when brought thence into a summer temperature they go almost instantly to destruction. This is a standing objection made to the use of chill rooms for the preservation of perishable articles. If a temperature of 45°, or thereabouts, can be maintained with moderate ventilation, this objection to the use of chill rooms would in a great measure cease; but when the temperature is carried down to 34° or 36° Fahrenheit, the article must not be subjected to a much higher temperature for any length of time before use.

There are cases when these principles cannot always be observed, and yet where cold storage is required. In such cases mechanical means must be employed to do what gravitation, if permitted, would do better. Cold air will not of itself rise above its fountain to displace warm and foul air, and if the cooling material be lower than some parts of the material to be cooled, the cold air will not ascend and do the necessary work unless mechanical means are used to force it up. In such cases fan blowing and other similar means are resorted to, and where these means can be relied upon at all times they may answer the purpose; but where the motion of the fan, etc., is contingent upon something liable to fail, as the motion of the car and the like, there is danger in trusting to it; for should the car come to a stand-still, the fan will come to a stand-still likewise, and the necessary work will not be done. But if the fan be carried by an independent power, which will go on whether the car move or not, there is less objection to it, though then not as reliable as the force of gravitation for doing uniform and constant work.

In respect to the first principle referred to, to wit, that the temperature should be reduced no lower than is necessary to preserve the article stored or being transported, the use of

salt and ice to reduce the temperature to near freezing is very objectionable: (1). It is injurious to the keeping qualities of the article thus treated. (2). It requires double or treble the quantity of ice to do the work and at least three times the amount of attention, and considerable more expense than is necessary to preserve the articles in a much better condition, and for a much longer time. The conditions of the preserving room should be as near as possible to that of a cool November day, with a gentle breeze, and the thermometer about 40° or 45°.

The construction of the car is as follows: The raised portion of the roof, or clear-story, as it has been called, forms an ice-box, which is filled from openings in the top without disturbing the freight. The air which enters the car is reduced to the proper temperature by passing through tubes under the ice, which are shown in the engraving.

The car is inclosed in a jacket composed of horizontal air passages, from end to end of the car. The object of this jacket is to cause a free circulation of air which has not been heated by contact with surfaces exposed to the direct rays of the sun, thereby cutting off the influence of the direct ray upon the chamber of the car amounting, often, to a difference of twenty to thirty degrees of temperature. These air passages being closed for use in cold weather, become insulated air spaces serving to protect the chamber of the car from the influence of extreme low temperature in winter. This arrangement, it is claimed, makes this car peculiarly a summer and winter car—protecting the contents of the car from heat in summer and cold in winter.

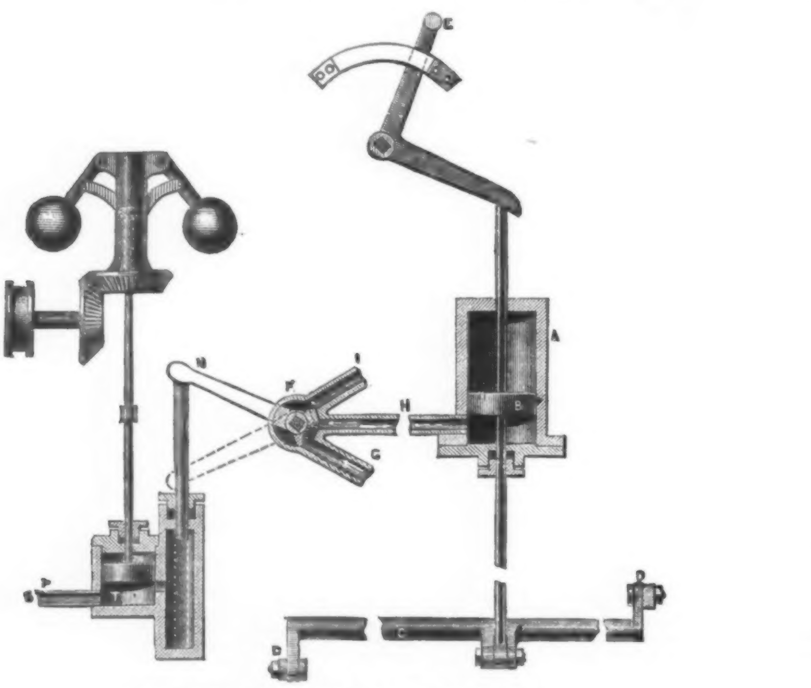
The car is also provided with ventilators communicating with the horizontal air passages in the roof, discharging at the ends of the car through openings, shown in the accompanying drawings. The warm foul air of the chamber is forced through these ventilating flues by the descent of cold air from the ice chamber into the body of the car, into the horizontal air passages already described as discharging at the ends of the car.

The bottom, ends, sides, and top of this car are insulated from the influence of outside temperature by means of a series of confined air spaces, formed by the use of thin ceiling boards and felt paper. The number of these spaces is usually four, embracing the use of five coatings of felt paper and five thicknesses of ceiling lumber, and to make the walls, bottom and roof of the car almost absolutely impervious to the influence of the outside temperature, summer or winter.

AUTOMATIC STEAM SHUT-OFF.

In order to meet the views of those who have written and spoken of the danger of allowing steam locomotives to run over the street tramways, means have been invented for automatically shutting off steam when the speed exceeds the limit of what is considered safe. The following method has been recently patented by Mr. H. Hughes, of Leicester. In carrying out his invention he employs a steam brake cylinder, A, having fitted therein a piston, B, which is connected with a rocking shaft, C, for acting through the intervention of levers, D, or other suitable devices upon the wheel brakes (not shown in the Fig.), and is also arranged in connection with the regulator handle, E, for controlling the admission of steam to the engine cylinders in such a manner that, when the brake piston, B, is operated by the admission of steam into its cylinder, the brakes shall be applied to the wheels and the steam shall be simultaneously cut off from the engine cylinders.

The supply of steam in the brake cylinder, A, is controlled by preference by means of a three-way valve or cock, F, arranged in connection with three pipes or passages, G H I,



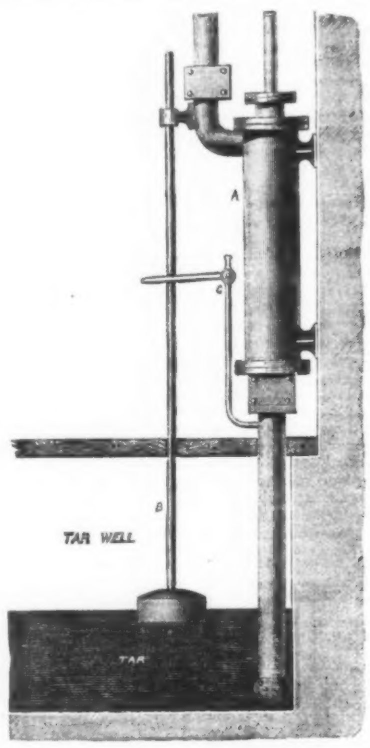
AUTOMATIC STEAM SHUT-OFF.

one of which, G, is employed for the introduction of steam to the valve chamber, K: another, H, for conducting it thence into the brake cylinder, A, and for returning the exhaust steam therefrom, whilst the third pipe or passage, I, is intended for conveying away the exhaust steam so returned. On the spindle of this valve or cock, which is continued to both ends of the engine, there are mounted handles (not shown in the drawing), for the facility of turning the same by manual power when required, and also a projection, M, whereby it is operated automatically.

The automatic apparatus consists of a governor driven by the aid of gearing and a belt and pulley from one of the axles of the engine, and arranged in conjunction with a throttle valve, T, in such a manner that when the maximum speed to which the apparatus is set (which may be varied as required) is exceeded, steam conducted from the boiler by the pipe, S, shall be admitted below or behind a plunger piston or valve, acting upon the projection, M, in such a manner as to turn the valve or cock, F, from the position shown by dotted lines to that indicated by full lines, and admit steam to the brake cylinder, A, whereby the brakes will be put on the wheels, and the steam will be simultaneously cut off from the engine cylinders, by which means the engine will be immediately retarded and promptly stopped. —*Eng. Mechanic.*

IMPROVED GAS TAR PUMP.

Every engineer knows what happens to any pumping apparatus if a hole should break out in the suction or tail pipe. In the proportion that any such hole admits air into the tail pipe by each stroke of the pump, in the same proportion is the volume of liquid raised by each stroke diminished.



Taking advantage of this fact, I provided an artificial air-hole to the tail pipe of the tar pump. The air-hole possessing the self-acting property of adjusting the size of its orifice, so as to admit the precise quantity of air that will compel the pump, at whatever speed, to continue pumping and maintaining the flow unbroken, and at the same time constrain it to draw the tar only *as fast as*, but *no faster than* it runs into the well. The accompanying sketch shows the apparatus by which all apprehension and danger have been got rid of. A, tar pump; B, float in well with stem above; C, air cock opened, shut, or regulated by the rising or falling of B.

The level of the tar in the well, having been fixed about one third of its contents, never varies in depth more than from 1 to 2 inches. The float and stem, B, rising or falling with the slight changes in the tar level, correspondingly opens or closes, by means of a small lever, the orifice of the air cock, C, and thereby regulates the volume of air admitted by it into the tail pipe. The air cock contrivance, while never allowing the pump to lose its *fang*, has in every way the whip hand of the pump, A, which it never allows to draw more nor less per stroke than the volume of tar that is for the time being deposited in the well. This it has continued to do uninterruptedly day and night during the last nine months, and has required no looking after whatever.

AIR ENGINES.

The object of the invention of Mr. R. Ebert, of London, is to transmit power to any required distance, and in any required direction, by means of the pressure of the atmosphere at the ordinary density of between 14 and 15 lbs. to the square inch, and is designed to supersede the air engines now generally in use which work by compressed air, for which purpose he employs an engine similar in construction to the ordinary steam-engines, but having the slide-valve chest open to the atmosphere; air at the atmospheric pressure entering the cylinder through the ports in accordance with the action of the slide-valve, and bearing or pressing against one side of the piston, the other and contrary side of the same exhausting through a tube into a receiver or chest, to which is connected air pumping machinery for the purpose of exhausting the air from the receiver, which latter may be placed at any convenient distance from the engine. To the exhaust-pipe between the cylinder and the receiver he fits a stop-cock, which when closed cause the engine to stop. To the same pipe, and somewhat nearer the cylinder, he also fits a throttle-valve, which he connects to a governor or speed regulator operating as in the case of ordinary steam-engines. By the partial opening or closing of the throttle-valve the exhaust from the cylinder is more rapidly or slowly effected, and the speed of the piston and of the engine thereby regulated. The air pumping machinery may be worked by steam, water or other power, and may be placed at any convenient distance from the receiver, to which it is connected by tubes.

THE HIGLEY ANTI-FRICTION ROLLER BEARINGS.

The devices for diminishing friction upon car journals and the consumption and cost of lubricating material are exceedingly numerous. One of the most recent and apparently successful appliances for this purpose is the Higley roller-bearing, constructed upon the principle of the well known anti-friction rollers used upon grindstones. The principle, in its application to car-journals, is not a new one, but the method of its application in the present instance has some peculiar features which deserve attention. These features are shown in the diagrams. Fig. 1 is an end view of the journal box in which the position and relative size of the journal and rollers are seen. Fig. 2 is a horizontal sectional view of the rollers with the shafts running through them. It will be seen that, one of the rollers being single, and the other double, they can thus be made to interlap, which brings the shafts upon which they run nearer together, and also equalizes the weight upon the ends, forming a bearing which will not twist or get out of line, as is the case with

FIG. 1.

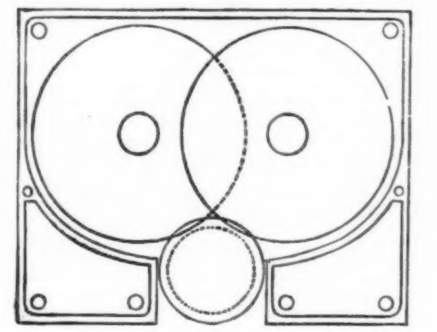
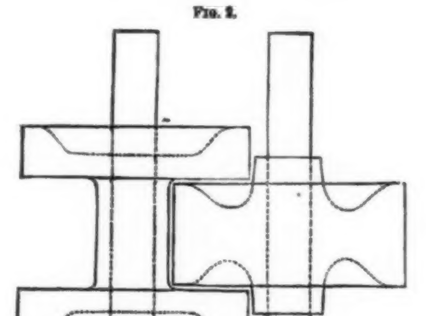


FIG. 2.



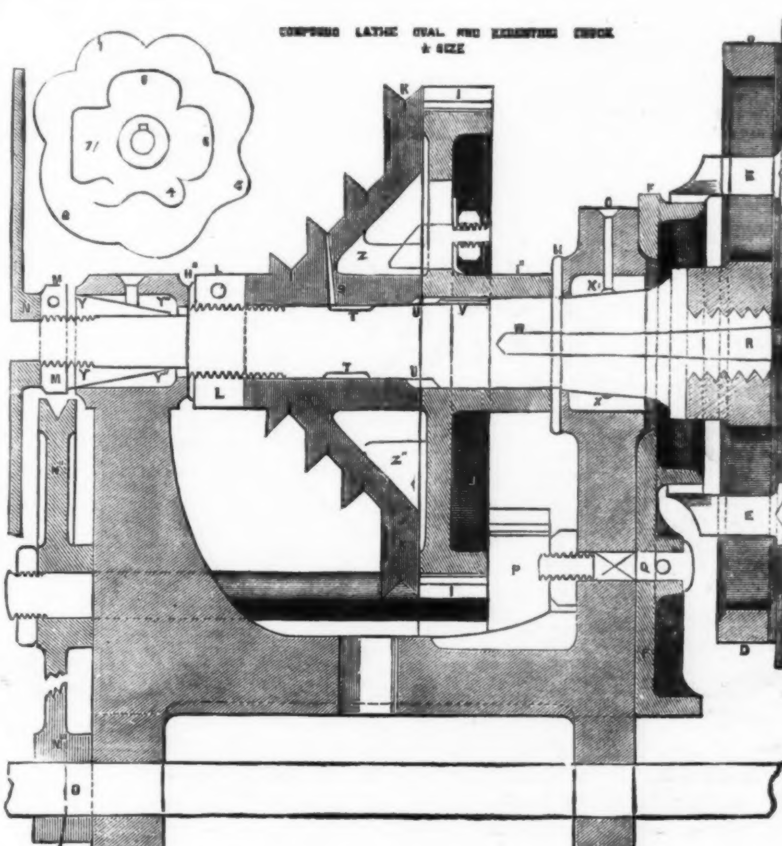
ANTI-FRICTION ROLLER BEARINGS.

the ordinary grindstone rollers. The roller shafts are about one-sixth the diameter of the rollers, and as the face or circumference of the rollers moves at the same rate as the journal upon which they rest, the traveling surface of the sliding friction will necessarily be one-sixth of what it would be if the journal was running in the ordinary bearing, and the cost of oil and packing reduced in the same ratio. The diameter of the rollers exceeds that of the journal in the proportion shown in the diagram, and consequently a larger box is required to hold them, and also, we should say, some additional strength of material in which the roller-journals run. How the lubrication of these journals is provided for we are not advised.

The advantages claimed for these bearings over ordinary ones are less liability to get out of order, less care, less danger of heating, a saving of three-fourths the present cost of oil and packing, and one-third in motive power. They have been extensively applied to street cars during the past six years, and about a year ago they were put upon an express train on the Wabash Railway, and the general superintendent and master car-builder testified to a great saving in oil, fuel, and power, and with no hot boxes. A heavy sleeping car on the Lake Shore road was also fitted up with them in December last, and has run 2,192 miles per week, with no trouble from the bearings. A dynamometer test has shown that the saving in power required to start a car fitted with these bearings, as compared with what is required to start a car with ordinary ones, is as 3 to 8.—*National Car Builder.*

COMPOUND LATHE AND OVAL ECCENTRIC CHUCK.

THIS sketch is half size for a 5½ in. centre lathe—with this exception, the steps of the speed cone should have been one quarter inch instead of $\frac{3}{16}$th, and the headstock half an inch longer, or the full size for a 5½ in.—*i. e.*, 9 in. long. This is a consideration in lathes that have very heavy chucks to carry; in fact, if extended another inch, it would be all the better, but at the same time we do not want anything out of proportion or the whole of our bed taken up with headstock. A is a screw nose to put the chucks upon, which are various to hold the various materials upon which you wish to manipulate. This passes through the tangent wheel or dividing plate, B, which full size should be 6½ in. diameter, and cut upon the edge with Whitworth's ⅛ in. pitch, as it is usually called, or 12 threads to the inch only, brought up to the knife edge instead of being rounded off top and bottom, and will give 240 teeth to the wheel. A ring, or, more properly speaking, two rings, should be made upon the face of plate, and the one outside divided into 36, and those on the next line subdivided into 10 or 360 parts in the whole, and this nose continues through the transverse slide, B' and B'', and forms a pivot or centre upon which the dividing plate revolves. The slide B' and B'' being the eccentric chuck or slide which throws the nose out of centre by a screw and nut for the purpose, the lug, etc., being cast upon the slide for the purpose of holding nut for screw. C C is the long slide which, when motion is given to it by the rubbers or tappers, E E coming in contact with the eccentric ring, F F, which is adjusted and fixed by the bolt, G, upon the face of the headstock. Give the oval motion by moving the slide, E C, upon the foundation chuck, D D, the rubbers passing through D and being fixed in C C. G is the oilway to front bearing cone; H, an iron washer case-hardened; I I is a cog-wheel 45 teeth, ½ in. pitch, or No. 6, P' pinion, 17 teeth same pitch. This is the back motion. This differs from the back motion in general use. There are several defects in the old which I wish to avoid, which may be pointed out and the advantage of this shown at some future time, I I being the wheel with a long sheave. I', or boss, and the catch or lock to lock it with the speed cone, Z being the feathers to hold it. K, speed cone; L, adjusting lock nut; H', iron friction washer, case-hardened; M, back adjusting nut for back cone, spindle coming through to take various templates; N, see above, 1, 2, 3, 4, 5, 6, 7, N''. Gut wheel driving pinion for slow back gear, the whole N'' lever upon the shaft, O, at bottom, which will be used for various purposes, holds the copper or rubber consisting of a piece of bone. With this arrangement many things can be done little dreamed of. P showing the position of pinion when in place for working P'' being out of gear, the coned part, B, is for the centre for mane, nose, or lathe-spindle; and the extension, W, for the convenience of passing wire up through chucks for drills, turning small screws, etc. S is an oilway through speed cone, leading into the recess, T, which forms a reservoir for oil for spindle: V V, recess for allowance for adjusting front cone; V, a feather or key let into spindles and keyway—a good fit in the long sheave of cog: X X, coned bush, of which more anon, and Y Y the back cone, Y'' Y'' being the back cone bush for which a better material than steel or case-hardened iron can be found.—*Eng. Mechanic.*



COMPOUND LATHE AND ECCENTRIC CHUCK.

A MODEL OF A MINE.

A DEVICE for showing the character and interior of mines has been placed in the United States Circuit Court room in readiness for the trial of the suit of the Richmand Mining Company of Nevada *v.* the Eureka Mining Company, to determine disputed boundary rights, which is expected to come on almost immediately after the Court re-opens for business. The model is made altogether of glass, and represents the principal tunnels, shafts, inclines, ore chambers, etc., of the Richmond and adjacent mines in Eureka mining district, as they would appear if cut by horizontal and vertical planes, passing through Ruby Hill at points indicated by the glass plates upon a scale of 40 feet to an inch. The size of the model is 6 feet by 4 feet, and 3 feet in height to the apex of the mountain. There are altogether 40 large plates of glass, besides the uprights, and the contour of the surface is the exact shape of the ground. The lodes and veins of ore are boldly shown painted in red, and the drifts are traced in black ink. Every detail is distinctly marked, so that it is easy to gain clear knowledge of all particulars. Mr. N. Wescoat, civil and mining engineer, of Nevada, made the surveys, and he, assisted by Mr. C. T. Healey, constructed the model. This device is similar to the one showing a model of New Almaden Mine, exhibited at the Mechanic's Institute Fair a few years ago. That, however, was on a smaller scale, although made in the same way.—*Scientific Press.*

SINKING THROUGH AQUEOUS STRATA WITHOUT PUMPING MACHINERY.

ABOUT four years ago a company was formed to work some mines discovered at Huntington, just beyond what had heretofore been regarded as the limit of the Cannock coal field, a "fault" intervening between Huntington and the West Cannock Company's colliery. The borings in search of coal showed that overlying the minerals were 120 yards of water-bearing strata, yielding such large volumes of water as to render sinking by the ordinary process a matter of extreme difficulty and enormous expense; yet as the area to be worked is large, and the mines are valuable, it was determined that the mines should not be abandoned, and that Chaudron's system of sinking without pumping machinery should be tried. As this is the first place in England where this system has been introduced (though it has since been introduced at Whitby), the members of the Mining Institute of North Staffordshire, recently, visited Huntington to inspect the workings. It may be stated that Chaudron's system is expensive, and for that reason is only recommended where large quantities of water are met with, but it is safe in operation, and certain in results. The operations are all carried on from the top of the pit, and no man descends till the shaft is finished. It was first requisite to erect sheds for engine, platforms, and other purposes, with a strongly braced timber beam to which the tools are attached. The boring commenced in January last, but owing to breakage of tools, some of which were in the first instance made too brittle, much delay was occasioned, and up to the present time only about 80 yards has been done to the pit inspected. The difficulty as to tools has at length been overcome. The work began by suspending a small boring tool over the pit, and lowering it till the top end is level with the working platform. The manipulation of the ponderous tools (one of which, used on Monday, weighed 12½ tons) is a work of great ease, owing to the arrangements of the machinery. The apparatus is gradually increased in length as the work proceeds by timber rods fastened to each other by screws. The first boring is done with a smaller tool; for instance, the sinking is 19 ft. diameter, but a smaller tool is first used 6 or 7 ft. diameter, and this is continued 15 or 20 ft. ahead of the larger bore. Each time a blow is given laborers on the platform turn the tool round, so that every part of the working surface at the bottom is operated on. The next process after the boring is finished will be the tubbing. The cast iron rings or cylinders to be used for this purpose are being made on the premises, and some of them were shown to the visitors. Each ring, cast in one piece, has inside flanges top and bottom, and a parallel strengthening rib in the middle of their depth, and the flanges are so carefully turned as to render them absolutely parallel. As soon as the shaft shall be finished these rings are to be lowered one after another, the bottom one resting on solid stratum, the space between the other rings and the water-bearing strata being filled up with cement, the shaft being thus perfectly water-tight. Though, as we have stated, the sinking or boring is as much as 19 ft., the finished shaft will only be 15 ft. It should be explained that, after the working drill has been employed the necessary time, it is withdrawn. Then a spoon is lowered. The bottom of this huge iron vessel consists of flaps which open upwards when it is lowered to the bottom of the bore-hole by the aid of the engine, and the débris which is usually reduced to very fine bits—in fact, almost reduced to powder—enters. As the tool is withdrawn the flaps close, and 125 to 150 cubic feet of débris is brought up at one time. A second shaft is in progress. The members present expressed themselves favorably as to the Chaudron system.—*Mining Journal.*

LOCATING AND DESCRIBING MINING CLAIMS.

WHO MAY TAKE UP CLAIMS ON THE PUBLIC LANDS AND HOW IT SHOULD BE DONE.

THE Colorado Springs *Gazette*, of recent date, contains an article directing miners as to the mode of procedure proper to be observed in the locating of claims, illustrating the same with a diagram, and which, if the subject had been treated a little more fully, as we purpose doing in the present writing, would have been of great service to the prospector.

The law enacted by Congress, May 10th, 1872, the provisions of which are still in force, declares all mineral deposits in land belonging to the United States to be free and open to exploration and purchase, and the lands in which such deposits are situated to also be free and open to occupation and purchase by the citizens of the United States, and by those who have declared their intention to become such, under regulations prescribed by law, and according to the local customs or rules of miners in the mining district where such deposits are situated, in so far as such rules and customs are applicable and not inconsistent with the laws of the United States.

Under the term mineral deposits is here intended to be included every kind of metal and mineral, gold, silver, iron, tin, coal, salt, sulphur, etc., though the quantity of land that may be claimed, and the provisions under which it is to be secured and held, vary somewhat with the character of the deposit taken up.

VIOLATING THE STATUTE.

The law, as will be seen, is very clear and specific as to the class of persons who are to be permitted to enter upon and occupy the public lands for the purposes of mining. They must either be citizens of the United States or persons who have declared their intention to become such; no others have any right to explore or purchase the mineral deposits on the public domain, nor yet, according to a strict interpretation of the law, to be in the occupation of the lands in which such mineral deposits are found.

There are at the present time not less than 50,000 people engaged in mining on territory belonging to the United States, who are not citizens and who have never declared their intention to become such, being, in fact, ineligible to naturalization. We refer, of course, to the Chinese, who, for more than a quarter of a century, have been suffered to mine on the public domain, except as they were prohibited from doing so by the local regulations of certain districts, and who of late years have been pouring into the mineral regions by every avenue of travel, and there, either through location or purchase, have possessed themselves of mining claims without let or hindrance.

The prohibitory clause was engrafted upon the statute regulating this subject, with special reference to this class of foreignors, who it was not intended by Congress should be allowed to enter upon our mineral-bearing lands, and there quietly appropriate and carry away their valuable contents to their rapid impoverishment and the prejudice of our own citizens. To read this statute by the purpose of its framers, it would declare in the most positive terms that no person of Mongolian origin shall be permitted to mine upon or even occupy this portion of the public domain. It will be observed that the law declares that this class of persons shall not only be debarred from exploring and purchasing these mineral lands but also from their occupation. They have no right to be on them. Their very presence is a trespass, since they are there inferentially for the purpose of mining; and why these intruders upon our common heritage have not been sooner ejected therefrom is a matter that those intrusted with the execution of the law should feel called upon to explain.

Supposing the party desirous of taking up a mining claim has a legal right to do so, he will first examine and see that there is no valid prior claim in the way. There being none, and the location to be made being on a lode or vein, he will ascertain as near as may be where is the most valuable portion of the same and there place his central stake, due regard being had to the natural facilities that exist for exploration and ore extraction.

Under existing laws 1,500 feet or less, but no more, may be taken up on any lode or vein by one person or company, the number of feet claimed to be stated on the notice, which must be signed by all the claimants, and set forth how many feet are claimed on each side of the central post or stake on which the notice is affixed and the direction in which the same extends. For this purpose, the following form might answer, heading the same:

NOTICE!

We hereby give notice that we have this —— day of ——, A. D. 187–, located this the (here insert the name of the ledge or vein, and also of the claim taken up). We claim 1,500 feet in and along the vein, linear and horizontal measurement. We claim 1,200 feet along the vein running in a northwesterly course from this central stake and notice (or discovery shaft if one has been sunk), and 300 feet running along the vein southeasterly from the same. We also claim 150 feet on each side of the vein from center of crevice, as surface ground.

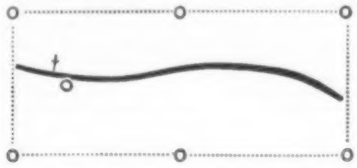
A. B. } Locators.
C. D. }

It would also be well to mention in the notice the name of the district, if one has been organized, in which the claim is located.

As the law requires that all locations shall be so distinctly marked on the ground that their boundaries can be readily traced, locators should be careful to describe them by reference to such permanent natural objects as may be in the vicinity, and also put up centrally and at all angles large posts, indicating clearly the outlines of their claims, as shown in the above diagram.

The curved line running centrally across the cut denotes the position and course of the vein; the cross above it the site of the location post or stake, and the circle below that

of the discovery shaft. Stone or other durable monuments may be substituted for posts, or these may be made to supplement the use of the latter where considered necessary.



The more readily a location can be identified by such description and monuments, the more secure the claimant's title.

RECORDING CLAIMS.

Within 20 days, or what under the circumstances might be considered a reasonable time of making the location, notice thereof, fully describing the claim, must be filed for record with the District Recorder, or if there be none, then with the Recorder of the county in which the claim is situated.

EXPENDITURES REQUIRED.

Within one year from the time that a claim is located, whether it contained 1,500 feet or less, $100, at least, in work or improvements must be expended upon it, and the same every year thereafter until it is patented. Where there is more than one claimant interested in a location, this expenditure may be made on any one or more of the joint claims, or on a tunnel designed for their development. From this provision, claims located prior to May 10th, 1872, are excepted; an annual outlay of $10 for every 100 feet answering in this case. Failure to make the required expenditure as above stated, renders all claims liable to re-location. If locators fail to make the proper expenditure within the year, but on it before re-locations made, they will save their claims.

BLIND LODES.

As no claim can be recorded till the vein or lode has been discovered within its limits, the claimant must, when it cannot be traced on the surface, open the ground sufficiently to determine its presence, and, if possible, also its course, as a means of enabling him to fix its surface location. Applicants for patents for lode or vein locations pay at the rate of $5 for every acre and fractional part of an acre contained therein.

PLACER CLAIMS.

Of placer grounds, no person can take up more than 20 acres, and no association or company, which shall be composed of at least eight *bona fide* locators, more than 100 acres, the government prices of placer mines being fixed at $2 50 per acre. The proceedings to be observed in taking up and securing this class of locations, and in obtaining patents therefor, are, in the main, similar to those required in the case of vein mines, the amount of work demanded to be done upon them being governed by local regulations.

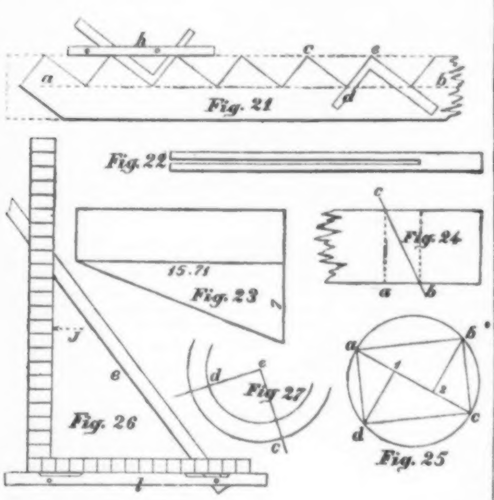
As a means of posting himself fully in regard to the laws governing these matters and the locating of coal and various other mineral producing lands, every miner should procure a copy of the United States laws lately compiled, and for sale at the office of this paper.

(Continued from SUPPLEMENT No. 88.)

HOW TO USE THE CARPENTER'S SQUARE.

By JOHN O'CONNELL, Millwright, St. Louis, Mo.

Plain Stairs.—Fig. 21. First determine the height from the top of the floor on which the stairs are to be placed to the top of the floor above, also the run of the stairs. It is necessary to plumb down from the top to get the run or horizontal distance correct. The stringers for stairs are cut top and bottom like a brace of same rise and run, of course measuring along the inner dotted line as you would measure a brace if the point were to be cut off and let into the post or beam.



Suppose the vertical height to be 10 ft. 4 in., and the rise for each step is required to be about 8 in.; divide the height in inches by 8 to obtain the number of steps. The quotient is 15½. As it is not advisable to have a half step, make the number of steps 16, and dividing the total height in inches by 16, we obtain 7¾, the rise in inches of every riser or step. Suppose the run of the stairs is 10 ft. 5 in.; divide this distance in inches by the number of steps, which is one less than the number of risers, as the upper floor forms a step to the last riser. The quotient, 8⅓ in., is the neat width of each step; to this there being generally added 1¼ in. or so for a nosing or projection.

If it is not desired to plane up the edge of the stringer, strike the chalk line *a b* about the proper distance from the edge, and lay the square on this mark, as at *d*, taking the width of step on one arm, and the rise of step on the other. If the edge of the board is dressed straight, the square may be laid on as at *h*; a piece of board with a slot sawn through edgewise, as shown by Fig. 22, when slipped on the square and and fastened with screws, making a convenient contrivance for laying out stringers. Generally a piece of thin board is cut of the form *c d e*, with a piece nailed to the edge *c* for a guide. The bottom riser must be made less in height than the others by the thickness of the step. For instance, if the steps are 1½ in. thick, the bottom riser should be 7¾ in.—1½ in., or 6¼. in height. It is sometimes inconvenient to put a support under a long stairs. In that case the triangular piece *c d e* should not be cut out but a groove made of same form, with a width equal to the thickness of the step and a depth of about half an inch. When the steps are well fitted into these grooves, and ⅝ in. bolts, with nuts, are run through across the stringers at about every five feet in length and passing close under the steps, the stairs are made very rigid when the bolts are well tightened.

Hexagonal and octagonal boxes or hoppers. The cuts for the edges of the pieces of a hexagonal hopper are found by subtracting the width of one piece at the bottom, viz., the width of same at top, and taking the remainder on the tongue, and depth of side on blade. The tongue gives the cut. For the cut on the face of the sides, take 7/12 of the rise on the tongue, and the depth of side on the blade. The tongue gives the cut. The bevel for the top and bottom edges is found by taking the rise on the blade, and the run on the tongue; the latter gives the cut.

To find the cut of an octagonal hopper for the face of the board and also the edge, subtract the rise from the width of side; take the remainder on the tongue and width of side on blade; the tongue gives the cut. The edge of the stuff is to be square when applying the bevel. The bevel for the top and bottom edges of the sides is found by taking the rise on the blade, and run on the tongue, the latter giving the cut. This makes the edges horizontal. The edges are not to be beveled till the four sides are cut.

Conveyors. Let us assume a conveyor to have the following dimension: diameter of shaft, 5 in., length, 14 ft., pitch of flights or screw, 7 in. Next, cut a piece of stiff paper of form of Fig. 23. The length of this pattern is equal to the circumference of the shaft 5x3.1416, or about 15.71 in. The vertical side of the triangle shown on the pattern is the pitch of the conveyor, or 7 in. The hypotenuse of this triangle is the length of the spiral for one round. Lay off the pattern lines on both sides of the paper. Draw a line on the shaft parallel to its axis. Lay even with this line, the 7 in. side of the pattern triangle, wind the pattern round the shaft and draw the course of the spiral along the hypotenuse; continue the spiral by shifting the pattern 7 in. further on. To find the whole length of the spiral, we first determine how many times the length of shaft contains the pitch; the quotient is 24. This number multiplied by the length of the hypotenuse of the pattern, is the total length of spiral.

If the shaft were octagonal but with the same pitch, we divide the pitch by the number of sides, which gives ⅞ in. for the pitch on one side. Take a short piece of board as wide as the diameter of the shaft, and taking ⅞ in., or a multiple thereof, on the blade, and the width of one side of the shaft, or the same multiple thereof, on the tongue, place the blade even with the lower edge of the board at *a b*, Fig. 24, and draw the diagonal *b c*. Cut off the end of the board through this diagonal, tack a strip on the lower edge as a guide to rest against the side of the shaft. This pattern will now mark off the spiral, whether right handed or left, on every side successively.

Sawing Timber. Fig. 25 shows how to find the largest rectangular stick that can be cut from a round log. Divide the diameter *a c* into three equal parts. Square out from these divisions by 2, to the circle representing the log and connect the points *a, b, c, d*.

Scales. Fig. 26 shows another use for the square. If a person is drawing a machine on a scale of 1½ in. to the foot, he may simply lay a common rule, *e*, under the square, touching the 12 in. mark on the blade, and the 1½ in. mark on the tongue; he then possesses a contrivance by which he may easily reduce from one scale to the other. For instance, if a piece of stick 2¾ in. square is to go into the construction, the draughtsman finds the 9¼ in. mark on the blade, that is, 2¾ in. back from the 12 in. mark, and measures square out to the rule, as at J. This distance is the reduced section of the stick. A straight mark, drawn on a table or a drawing board, serves as well as a rule.

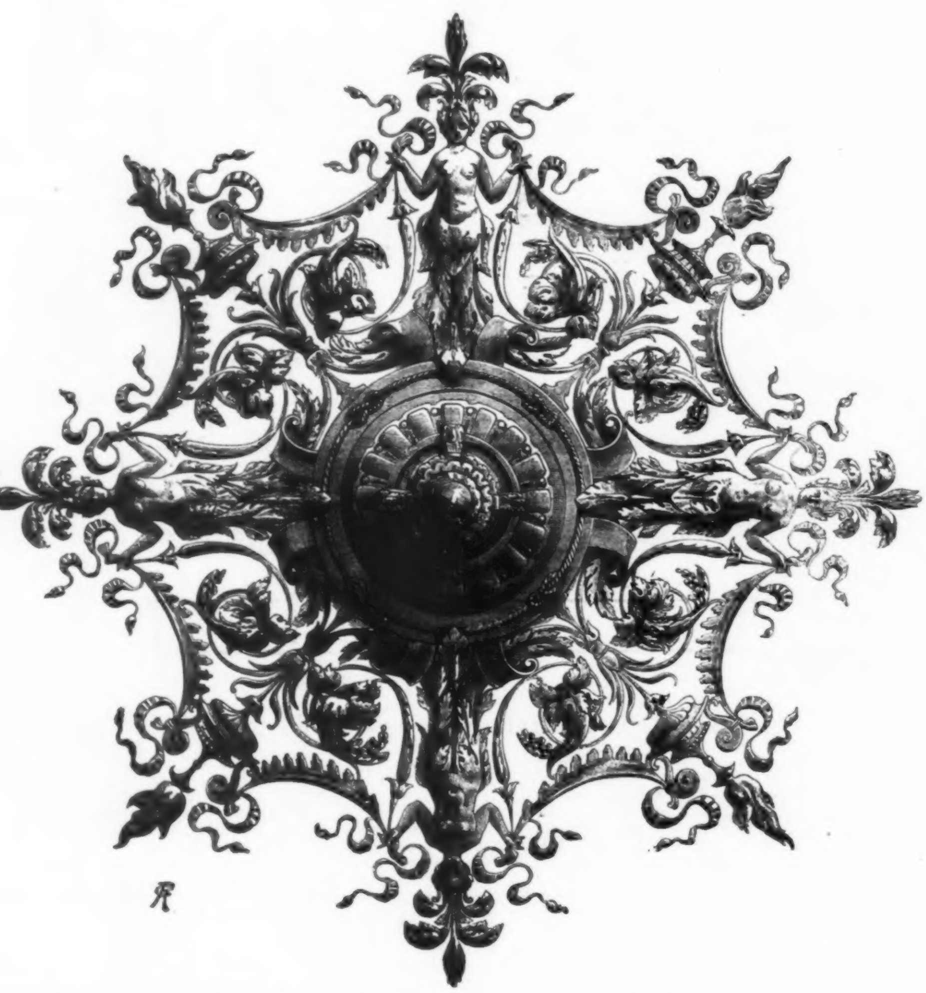
To test a square with the compasses, draw the two concentric arcs, *d* and *c*, Fig. 27 with radii of 6 and 8 in. Set the compasses to 10 in., and inserting one point anywhere on the outer arc, as *c*, mark the exact distance on the inner arc, as at *d*. Connecting these points with the center of the two arcs, we have an exact right angle with which to compare the square. To test a framing square, it is best to draw arcs of 12 and 16 in. radius, laying off 20 in. between *c* and *d*.

The square may be more quickly tested by laying it on a wide board, placing the blade parallel to one edge, which must be planed perfectly straight, and drawing a fine line along the tongue. The square is then turned over, so as to rest in a reversed position on the opposite side of the line just drawn. If the square now exactly coincides with the line and the board-edge, it is a perfect right angle. A great recommendation of this method is that an inaccuracy of the scale is doubled by the reversing, and so made more apparent. If the square is not true, it should be set in a vise and draw filed.

Simple Calculating Machine. Fig. 26 shows the application of a long level to a square, by which some calculations can be made with greater ease and quickness than by the usual arithmetical process. The largest size of carpenter's bevel square placed under the framing square will answer in nearly every case, or any mechanic can make the bevel for himself with blades of steel obtained at a hardware store. One edge of each blade should be made perfectly straight and the edge of *l* should be filed down in several places to see the blade *e*, when placed under the square. If blade *e* were placed *on* the square, it covers up the figures on the latter. The two blades should be fastened together by a thumb-screw. There should be three holes in *l*, one near each end and one in the middle, and a notch filed by each hole, so that the blade *e* may be shifted when necessary.

To find the diagonal of a square by this instrument, set the blade *e* to 8¾ in. on the tongue and 12⅜ in. on the blade. Then screw the bevel fast; and supposing the side of the square in question is 11 in., move blade *e* to the 11 in. mark on the tongue, keeping blade *l* against the square, when blade *e* will touch 15 9/16 in. on the blade, which is the required diagonal. There is no special reason for using 8¾ and 12⅜; other numbers may be employed provided the proportion of 70 to 99 exists between them. In the problem just solved as in all that follow, the bevel being once set to solve a particular question will solve all the others of the same kind, till the bevel is altered.

To find the side of the greatest square which may be inscribed



CEILING ORNAMENT. DESIGNED BY H. PALLENBERG, COLOGNE.

in a given circle when the diameter is given.—Set the bevel to 8¾ in. on the tongue and 12 in. on the blade. The answer will be found on the tongue.

Given the diameter to find the circumference of a circle:—Set the bevel to 7 on tongue and 22 on blade; the answer will be found on the latter. In every case when a reverse problem is presented the bevel will solve it unchanged; we merely look for the answer on the other blade of the square. For instance, if, after solving the above, we are required to determine the diameter from the circumference, we still use the same bevel.

To find the circumference of an ellipse, or oval. Set 5⅝ in. on tongue and 8¾ in. on blade. Then set the bevel to the sum of the longest and shortest diameters of the ellipse on tongue, and the blade gives the answer.

Polygons inscribed in circles. In the following table, set the bevel to the pair of numbers under the polygon to be inscribed.

No. of sides.	3	4	5	6	7	8	9	10	11	12
Radius. Side.	56 97	70 99	74 87	Side equal to radius.	60 52	98 75	22 15	89 55	80 45	85 44

pentagon which may be inscribed is 5·24 in. on a side. Hence for pentagons the bevel is set at 12 in. and 5·24 in. The number opposite each polygon gives its side when inscribed in a 12 in. circle.

The first table is usually most convenient.

Given the side of a polygon to find its apothem, or perpendicular. Set the bevel to the pairs of numbers in the table below. Thus for a heptagon, set 23 on tongue and 25 on

Sides.	3	4	5	6	7	8	9	10	11	12
Apothem side.	9 31	1 2	20 29	13 15	25 23	40 33	40 29	20 13	29 17	28 15

blade, and the answer will appear on the latter.

To divide a circle into a given number of parts, multiply the radius by the corresponding number in column A, and the product is the chord to lay off on the circumference.

Given the side of a polygon, to find the radius of the circumscribing circle. This problem has previously been tabulated, but by multiplying the given side by the number corresponding to the polygon in column B, in most cases we obtain the answer more expeditiously.

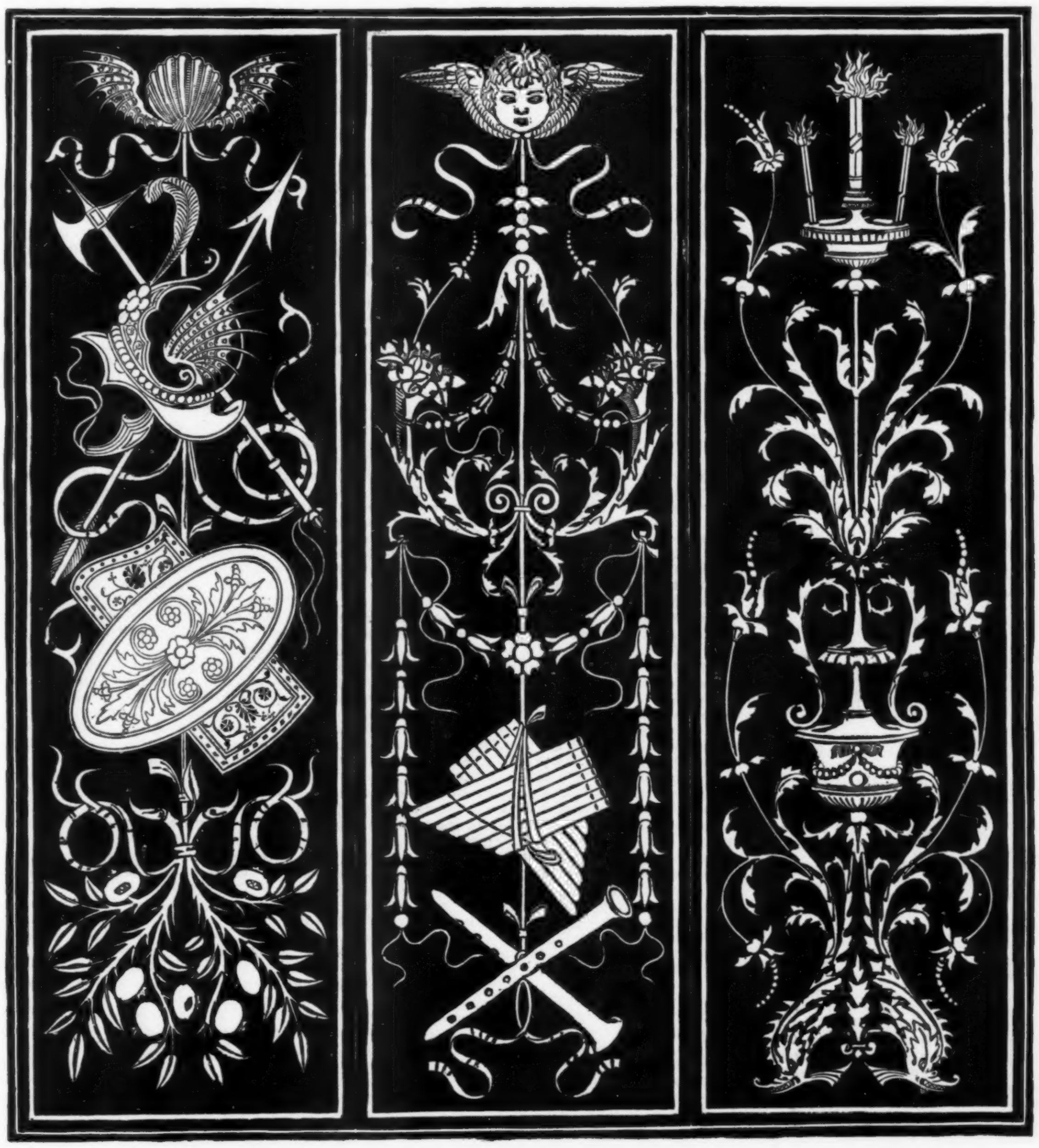
whether on tongue or blade, there also must be set the width of board in inches.

Square Yards. These problems require a bevel of 9 on tongue, and the length or width of the surface to be measured, on the blade. The bevel is then moved to the remaining dimension of the area on the tongue, and the number on the blade indicates the square yards contained.

Gearing. To find the number of cogs in a wheel, pitch of cogs and diameter of wheel given:—Set the bevel to the pitch on the tongue and 3·14 on the blade.

Given the diameter of a wheel to pitch line, and number of cogs, to find pitch of cogs. A wheel 70 in. diameter has 146 cogs; what is their pitch? 146 in. being too great to set on the square, we take proportional parts, setting the bevel to 7/8 in. or 8¾ in. on tongue, and 1 5/8 inch, or 18¼ in., on blades. Tighten the screw, and move the bevel to 3·14 on blade, and the number given on the tongue multiplied by 8 will be the required pitch.

Given the diameter of a circle, to find the side of a square of equal area. Set the bevel to 9¾ on the tongue and 11 in. on blade. Then move the bevel to the diameter of the circle on the blade and the tongue gives the answer. When the circumference is given instead of the diameter, set the bevel to 5¼ in. on tongue and 19¼ in. on the blade.



MARQUETRY DESIGNS. BY S. PETRONIO, BOLOGNA.—*From the Workshop.*

If we require the radius of a circle which will circumscribe an octagon 8 in. on a side, we refer to column 8, take 98 parts on the blade and 75 on tongue, and tighten the bevel. As the side of a hexagon equals the radius of its circle, the side of an octagon must be less than the radius; hence we shift to 8 in. that end of the bevel blade which gives the lesser number, in this case, on the tongue of the square, as the 75 parts to which the bevel was set are less than the 98. The required radius is then indicated on the blade.

The following is another table, to be used for the same calculations. In a circle 12 in. in diameter, the largest

Names.	No. of Sides.	Gauge Points.
Triangle	3 sided	10·44
Square	4 "	8·49
Pentagon	5 "	7·06
Hexagon	6 "	6·00
Heptagon	7 "	5·24
Octagon	8 "	4·59
Nonagon	9 "	4·05
Decagon	10 "	3·71
Undecagon	11 "	3·38
Dodecagon	12 "	3·11

No. of sides or parts.		A	B	No. of sides or parts.		A	B
3	Triangle	1·732	·5773	8	Octagon	·7653	1·3065
4	Square	1·414	·7071	9	Nonagon	·6840	1·4619
5	Pentagon	1·175	·8006	10	Decagon	6180	1·6180
6	Hexagon.	Radius	side	11	Undecag.	·5634	1·7747
7	Heptagon	·8677	1·152	12	Dodecag.	·5176	1·9318

To inscribe three equal circles in a circle of given diameter. Set to 6¼ on tongue and 14 on blade. Move the bevel to the given diameter on the blade and the required diameter appears on the tongue.

Four equal circles require a bevel of 2·91 and 14.

Board Measure. A foot in board measure is 1 in. thick and 1 ft. square. Set the bevel to 12 in. on the blade and the length of board in feet on the tongue. Then move the bevel to the width of board in inches, on the blade and the area in square feet appears on the tongue. Wherever the 12 in. is set,

Miscellaneous Questions. The arms of a straight horizontal lever are 8 and 12. A weight of 9 lbs. is suspended from the shorter arm; what weight will balance it on the longer arm? Set to 12 on blade and 8 on arms. Move the bend to 9 on blade, and 6 is the answer on tongue.

What power is required to support a weight of 4 lbs. on an incline of 5 in 30? Set 5 on tongue and 30 on blade. Move the bevel to 4 (lbs.) on blade, and ⅔ (lb.) is obtained on tongue

A body is weighed in a false balance and in one scale appears to be 9 oz., and in the other 12 oz. What is its true weight? Find a mean proportional between these numbers, that is, the square root of their product. $9 \times 12 = 108$ $\sqrt{108} = 10·39$ ans. The same example is solved by the square by taking 10½, half the sum of 9 and 12, and 1½, which is the difference between 10½ and 9 or 12. The 10½ is now the hypotenuse of an imaginary right-angled triangle, and the 1½ one side. It has already been explained how to find the other side, or the answer.

A spout is 20 in. square; what is the diameter of a cylindrical one with same area of cross section? Set the bevel to 31 on tongue and 35 on blade Move to 20 on tongue and we obtain 22½, the answer, on blade.

NEEDLEWORK.*

By MARY W. WILLIS.

1. NEEDLEWORK, as we know, is one of the most ancient of the arts, and the results achieved, and the ingenuity in it, appear to have been highly prized in the earliest ages. In the song of Deborah, for example, the glories of the victors "spoils of needlework" are celebrated; and we read in the 45th Psalm of the "raiment of needlework" of the bride. Needles made of the bones of fishes and other animals are amongst the earliest relics we have of antiquity, and we still admire and wonder at such works as the Bayeux tapestry and various church vestments, which must have been produced with the rudest implements.

2. In these days, when every mechanical appliance in the shape of perfect needles, sewing threads and silks, to say nothing of the wonderful sewing machine, combine to facilitate and lighten work, it is to be regretted that the standard of excellence so commonly falls short of that attained in former times, with far inferior materials.

3. In the reign of Mary Tudor, there was only one needle-maker in England, a Spanish negro slave, and the needles he made must have been inferior to those still used in some outlying districts of the Continent, which bend at every stitch, though they have the one advantage of not breaking. When women lived much shut up, and books were few or none, the best and most cultivated of our sex found solace and delight in the art which, in this nineteenth century, has afforded to women like Harriet Martineau and Mary Somerville rest and relaxation from their severe mental labors.

4. It would be easy to fill a longer paper than this is intended to be with an account of needlework as a decorative art; but it is our present object to view it from the severely practical side—skill in plain needlework, meaning, as it does to thousands, personal decency, comfortable homes, and tidy children, in whose minds may be planted by its means the first seeds of love of order, cleanliness and respectability.

5. Much has been said of the superiority of French needlework, but a Woodstock glove is a sufficient proof that in England high mechanical excellence is attainable in needlework as well as in other handicrafts, such as cabinet-making, metal-work, etc., in which the English mechanic is unsurpassed. In mentioning the beauty of the stitching of the glove-makers, however, I am reminded of a melancholy fact attendant upon restricted mechanical skill, viz., that in the villages where gloves are made to perfection, it was not long ago impossible to get a sheet or table napkin tolerably hemmed, much less a shirt made. This shows the necessity of avoiding as much as possible too great monotony in the kind of needlework taught in schools. I believe that attention is now being paid to improving the teaching of this important branch of female education, which, indeed, is much needed; for how few servant girls, fresh from school, can be trusted with even the ordinary mending required in a household! An exhibition of school needlework was held last year in the theatre of the Albert Hall, under the presidency of the Princess Louise. It is true that this can hardly be accepted as a sufficient test, as it was difficult to get together an adequate number of exhibitors on short notice, but it is instructive to mark that the work on the whole was not of high quality; the patterns were very inferior, which is largely to be accounted for by the fact that the school-mistresses complain that they cannot spare the time required to teach needlework properly, in order to reach the standard required by the inspectors in other valuable but, I really believe, less practically useful studies.

6. Occupation which encourages the use of the hands has, besides, a valuable natural influence upon children, but it is not half enough considered in our schools for boys as well as girls. It is not found that Scotch children are behind ours in book-learning, though the shepherd lads knit their own stockings, and much of the fine cambric embroidery used for trimmings is, in Scotland, made by boys.

7. After the first rudimentary instruction in plain needlework, it will be found that cutting out and shaping garments, requiring as it does more thought and ingenuity, is generally neglected; but every possible means should be taken to enable children to apply the knowledge they have acquired to the making up and cutting out of their own frocks and pinafores. And here we would strongly urge the taking some thought for prettiness and taste, in color and design. The delight in quite young children in work like the kindergarten pricked patterns, in bright colored wools or cotton, shows that a love of bright color is instinctive in human nature, and is even beneficial when wisely directed. A reaction towards vulgar and extravagant finery is ever found strongest in those girls who have passed their youth in the colorless and ugly uniform of a charitable institution. Mr. Ruskin's Quaker student at the Working Men's College, we may remember, effected some useful improvements in the manufacture of certain colors, none of which could be found at a cheap rate pure and bright enough to satisfy eyes weary of gray and drab.

8. In most parishes there are Dorcas societies, where ladies who are above—and sometimes, I fear, incapable of—making their own clothes, expend their benevolent and kindly feelings for their poorer neighbors in constructing fearfully and wonderfully shaped garments. It has been our experience to see really beautiful needlework wasted on clothes, the inappropriate materials and radical errors in the cutting out of which must prevent either comfort or durability in wear—ill-fitting necks, arm-holes either too large for shapeless sleeves, or too small for the arms of the wearer, causing tearing out in a part where mending is most difficult and unsightly. There is another useful institution, common in most places, "The Needlework Society," which provides women with plain needlework cut out and prepared by the subscribers to the society. The few shillings a week to be thus earned are much sought after by wives and mothers, who thereby add to the scantier winter earnings of the men, whilst they have the advantage offered them that they can, at their option, purchase the garments they have made at the mere cost of the materials. Of the work of these poor women I say nothing; it is sad to see mothers of families who ought to have been taught the use of their needles at school, painfully overcoming this deficiency of their early training, as some (though alas but few) do later in life, and expressing their warm gratitude to the ladies who have helped them to surmount the difficulty.

9. It is not impossible, as it was some time ago, for ladies who wish to make, or at least cut out, their own dresses and under-clothing to procure excellent paper patterns, but these are costly, and for the most part unsuitable to the requirements of working people. It has to be remembered that the shirt for a gardener, blacksmith, or day-laborer requires to be of a much ampler and totally different cut from that which would be suitable and comfortable for a clerk, or the man who does not use his arms in laborious work; and the shift for a working woman, which alas! has often to serve the purpose of a nightgown as well, must be of thicker material and more voluminous cut than the corresponding garment of the lady of the present day, which, reduced to a minimum, threatens, as in the time of the first French Empire, to disappear altogether.

10. The question of patterns and cutting out seems to me a highly important one; why should not the Society of Arts undertake to publish good proved patterns, which might be registered, each garment in three sizes, pasted on cotton cloth, with clear instructions as to making up, the quantities required, etc.? These might be supplied at a low price to schools and work societies, and could be lent out, and used in teaching the children the art of cutting out and planning.

11. In the Society of Arts Examination of this year for needlework, I was again greatly struck by the want of the most elementary knowledge of pattern making displayed by nearly all the candidates, most of whom passed well in the other branches of the subject.

12. In these days of progress, when materials unsurpassed in beauty and cheapness (let the admirers of "the good old times" say what they will) are ready to our hand, we hope to see a reaction against that foolish notion of gentility, which looks upon skill in the humbler branches of one of the most delightful, as it is the most useful, of handicrafts, as vulgar and degrading. The sad lamentations over "nothing to do" are not heard, and the actual vice which springs from idleness among women of all classes is not found, among those who have been in youth trained to delight in industry and order, with their resulting love of beauty and fitness in all things.

13. I will conclude with a quotation from that great author who has done so much to further a reverence and love for work, and who raised his voice in his 80th year to protest against the spirit of "all slimness and imperfection in handicraft," which he feared in this nineteenth century was gaining ground in England. "Work is the mission of mankind on this earth. A day is every struggling forward, a day will arrive, in some approximate degree, when he who has no work to do, by whatever name he may be named, will not find it good to show himself in our quarter of the solar system; but may go and look out elsewhere, if there be any idle planet discoverable. Let all honest workers rejoice that such law, the first of nature, has been made good on them."

* A paper read before the Domestic Economy Congress, Birmingham, Eng., July, 1877.

MANUFACTURE OF SLAG WOOL.

HERETOFORE in the manufacture of this material the hot slag as it leaves the furnace has been subjected to the action of a jet of steam or air for the purpose of dividing it into extremely fine filaments, but the direct action of the steam has not been altogether successful in the production of a material free from impurities known generally in such manufacture as shot. Mr. Chas. Wood, of Middlesborough-on-Tees, has, therefore, devised some means whereby he believes a large proportion can be made entirely free from shot, thus leaving the fibres or filaments almost pure. He conducts the slag from the furnace by the usual slag runner and at the discharge end, and on one side underneath the slag runner he places an air or steam jet, preferably the latter; on the other side of the runner, and opposite the steam or air jet, he provides a large tube of wrought or cast-iron leading to a chamber or receiver, to be hereafter described. The mouth of the tube—that portion of it near the runner—is open on the lowest side, so that the shot coming from the slag as the wool is divided from the same, or in other words, as it is manufactured, is free to fall to the ground or into any suitable receptacle, while the slag proper goes into an ordinary slag box, or is otherwise disposed of as desired. Into the tube and beyond that part thereof which is not open he leads a second jet for the passage of air or steam, and the subject of this second pipe is that the air or steam which is forced through the same toward the chamber draws the wool or silicate cotton which has been produced by the first steam or air jet into the tube, and sends it on into the chamber; this chamber is constructed or formed of a series of frames of wire netting for the purpose of catching the wool blown into the same, and allowing at the same time the steam or air to escape.

With regard to the arrangement of the wire netting, he finds it most convenient to have them in a V or corrugated form, and to connect the apexes of (say) the V's what he terms draught plates, which tend to check the current of air or steam, and to allow the fine qualities of the wool to settle behind them in the angles formed by the V-shaped netting. Near the entrance of the chamber, and opposite the tube, he places a board or plate for the purpose of arresting any shot that may possibly be carried into the chamber through the tube, and thus stop the shot from contaminating the wool. A galvanized iron or other roof may be provided for the cage or chamber, but this may also be of wire netting or any other material. The invention then essentially consists in the employment in the manufacture of two air or steam jets, one to make the wool, and the other to draw it into and send it through a tube into a chamber or cage made of wire netting or perforated plates, or equivalent material, in such manner that the wool is caught by the sides, while the air or steam is able freely to escape without forming currents, and also a great side area of netting or perforations upon a comparatively small space of ground. The simple but effective means provided for arresting the shot, and dividing it from the wool, is also a very important feature in the invention.

BLEACHING WOOL WITHOUT STOVING.

BLEACHING with carbonate of baryta has the disadvantage that it leaves in the wool a white dust which renders the threads hard. On the other hand stoving offers notable inconveniences. To avoid these it has been proposed, some time ago, to supersede stoving by an immersion of the goods in a solution of bisulphite of soda, which is then decomposed by an acid, so as to produce liquid sulphurous acid instead of the gaseous acid which fills the stoves. The practical method of conducting this liquid process is not universally known, and is as follows: To begin with, the wool is scoured, and washed as thoroughly as possible. Then for 22 lbs. of wool is taken a cistern of white wood, large enough to permit of the working of the wool. It is filled with cold water, in which are dissolved 11 lbs. crystalline bisulphite of soda. Add then 4 lbs. 6 ozs. muriatic acid. The wool is then entered and steeped for five or six hours, turning over occasionally. Woolen goods are sticked and piece goods are winced in the liquid. The wool is then taken out, let drain, and rinsed.

In many cases the bluing beck is a sufficient rinsing.

For a second operation the beck may be strengthened by adding merely half the weight of materials mentioned above, provided that the second lot of wool is taken in hand immediately after the first. In this manner several successive lots may be worked with small additional charges, care being taken to run off the muddy deposit, and to make up the quantity of water lost at each operation.

We may also make use of another method, more complicated, but more effectual and regular.

The beck is only filled three-fourths full of water, and merely the muriatic acid is poured into it. On the other part the bisulphite of soda is dissolved in about 170 pints of cold water, and this solution is diffused in the most uniform manner over the wool which is spread upon the ground or placed in another beck. The sprinkling may be effected by means of a watering can or a force pump.

The wool thus moistened is steeped in the acid solution and the decomposition of the bisulphite—that is to say, the production of the sulphurous acid being effected in the very midst of the goods to be bleached, acts in a more direct and powerful manner. In this manner we have the advantage of always making use of the same acid bath, which, after every operation, retains a considerable quantity of sulphurous acid.

Wools bleached in this manner are similar in condition to those which have been stoved, but the operation is more regular, the goods retain a less decided smell of sulphur, and there is no fear of injury. The process, however, is somewhat more costly than stoving.—*Teinturier Pratique.*

NEW MORDANT FOR FIXING COLORING MATTERS.

EVERY one knows that coloring matters soluble in water can be absorbed by pulverulent bodies of a certain kind with an avidity which appears to be the same as that with which textile fibres lay hold of the so-called substantive colors. It has been demonstrated in this journal that starch seizes and retains with a very considerable power the aniline colors. Thus colored powders may be prepared which find numerous applications in the manufacture of paper hangings. We know that certain colorless precipitates, if formed in a liquid containing a coloring matter in solution, absorbs very considerable quantities, and still appear only faintly tinted. Of this kind we obtain very elegant results with the sulphate of baryta, if precipitated in liquids holding aniline colors in solution.

All such precipitates, however, have but a very secondary interest for the art of dyeing, and up to the present time there is no pulverulent or porous body known which is in a condition to act upon coloring bodies, both substantive and adjective, absolutely in the same manner as the fibre itself.

In consequence of researches in dyeing with aniline colors upon cotton, M. Reimann has succeeded in demonstrating the enormous power of absorption of silica and analogous substances for tinctorial bodies.

A compound of silicic acid has already been dyed with substantive colors. The attempt has been made, with more or less success, to communicate to powdered mica the brilliant hues of aniline dyes by steeping it in a solution of these products. But these attempts have never extended to other applications of the absorptive power of silica for colors.

The precipitate of silicic acid, which is separated from a solution of soluble glass on the addition of an acid, which appears in the form of a jelly, but is transformed on drying into a white, impalpable powder, proves, in a most striking manner, the property which it possesses, when brought in contact with the solutions of substantive colors, to seize hold of the coloring matter which they contain; and if mordanted and brought in contact with adjective colors, to dye up exactly in the same manner as a textile fibre. The dyes thus obtained are, at least, as solid as those upon vegetable fibre.

In particular, the aniline colors are thus capable of readily combining with silica, which then appears colored in a perfect manner. If in a glass containing solutions of magenta, of aniline blue, violet, etc., we stir up silicic acid, precipitated and washed with care, this acid takes up an intense color, which it retains after washing with water. It is only on boiling with water, or on treatment with concentrated alcohol, that the color disappears. But this takes place also with dyed fibre, for instance, mordanted cotton, which is decolorized if boiled in water, and still more readily if treated with alcohol. We may thus succeed in dyeing amorphous silicic acid with the solutions of aniline colors, obtaining very beautiful powder-colors, which may serve as pigments and in the manufacture of paper hangings.

But an application of far greater industrial importance is the utilization of these reactions in dyeing. Upon those fibrous matters, such as cotton, which do not take up the aniline colors directly and without preparation, it is easy to fix them by means of silicic acid. When the fibre of cotton, which shows itself extremely refractory against colors, is simply imbued with a compound of silicic acid, easy of decomposition, it absorbs such colors, especially the anilines.

A simple passage through a solution of soluble glass suffices to give cotton this power of absorbing colors. But we succeed still if we decompose the soluble glass upon the fibre; for this purpose the cotton, after being saturated with an alkaline solution of silica, and then steeped in dilute acid, so that the silica may be precipitated upon the fibre, if it is then cautiously washed and plunged into the solution of dye, it takes a bright, lively color, and, in addition, the shades obtained are more solid than those produced with the numerous mordants now in use.

The mordanting of cotton for aniline colors has chiefly been confined to introducing the fibre into an acid, with which rosaniline, trimethylrosaniline, forms salts sparingly soluble or altogether insoluble. Tannic acid, on account of the insolubility of its salts, is preferred by cotton dyers. Yet the compounds of tannic acid have not as lively a color as the salts of the aniline bases as they existed in solution. Hence shades dyed with a tannin mordant always appear rather flat.

This fault is entirely removed by the use of silicic acid. It is in fact found that the aniline colors fixed upon cotton by means of this acid are purer, and resist soap and alkalies better than those fixed with ordinary mordants.

The great power of silicic acid for attracting and fixing colors will be still better appreciated if we observe that, contrary to all analogy, wool cannot be dyed directly with aniline green. A passage through soluble glass, dyeing in a

beck of the green at a hand-heat, followed by a passage through a weak acid, are all that is needed in this case.

These properties of silicic acid have already been applied in cotton dyeing on a large scale with aniline colors, and have yielded admirable results.

M. Reimann has also undertaken other researches with the adjective colors, and has found that silicic acid lays hold of the different mordants, such as acetate of alumina and acetate of iron, precisely in the same manner as does cotton. It is thus that black shades may be dyed perfectly well.

It now remains to inquire if the silicic acid, like mica, is merely simply united to the coloring matter by a superficial attraction, or if this affinity is not perhaps due to a feeble proportion of alkali remaining in the precipitate. This last supposition presents itself to the mind so much the more readily, as it was found possible about a year ago that the aniline colors could be fixed upon cotton by an alkaline mordanting. M. Reimann has, therefore, sought to produce all the colorations obtained upon silicic acid upon the glass itself mordanted with fluoric acid.

If the affinity of silica for coloring matters merely depends on the presence of an alkali, experiments upon such mordanted glass ought to give a negative result, because in such we could not imagine the presence of a soluble alkali. If, on the other hand, the affinity of the acid is attributable only to a physical property of its surface, the mordanted glass ought to give the same, or at least analogous results.

In fact glass, whose surface has been treated with fluoric acid, seizes the aniline colors as perfectly as amorphous silica. The glass so prepared may even be mordanted with iron, and dyed black in a logwood beck, or a rust yellow, a royal blue, etc., may be produced. In consequence of the slight depth to which the mordant penetrates, as compared with the thickness of the glass, the shades are certainly light, but as far as it penetrates it is as perfectly stable as that produced with silicic acid.—*Dingler's Polytech. Journal.*

DYEING PAPER WITH ANILINE COLORS.

THE Berlin *Actien Gesellschaft für Anilin Fabrikation* recommends for this purpose the following set of colors:

For bluish-red	Rubine N, RRO.
" yellowish-red .	Rubine OR.
" orange	Coralline, Berlin brown and R.
" yellow	Martius-yellow.
" green	Methyl-green JB.
" violet.	Gentiana-violet B, BR, R, methyl-violet B, Hoffmann-violet 2 B.
" blue	Water-blue 2 B, 2 BS, R.
" gray	Soluble aniline gray.
" brown	Bismarck-brown, mode-brown.

For more brilliant shades of blue paper Nicholson blue 2 B, R, are sometimes advantageously used.

All these colors are simply dissolved in boiling water, with the addition of a little sulphuric acid in the case of a water-blue and gray, and are added gradually to the pulp. In most cases an addition of alum, sulphate of alumina, sulphate of baryta, or china does not interfere, but it is absolutely necessary to remove every trace of free chlorine by the addition of the hyposulphite of soda or of lime, before mixing in the color. In using blues and greens a little sulphuric acid brightens the colors, but the weight of acid thus used must not exceed the weight of the dry color.

ANILINE WRITING INKS.

THE following aniline colors are now widely used in the preparation of colored writing inks. The color is in each case dissolved in the quantity of boiling water mentioned, without spirit, and filtered. The addition of gum is not necessary, and, indeed, deprives the inks of their great advantage over ordinary inks, *i.e.*, the circumstance that they never clog or thicken on the pen.

If the writing when dry retains a bronzy appearance, more water must be added to the ink. For red use "rubine extra," dissolved in 150 parts of water. For blue-violet, methyl violet 5 B, Hoffmann-violet 3 B, or gentiana-violet B, dissolved in 300 parts of water; for a reddish-violet (a shade generally less liked for inks), methyl-violet BR, in the same proportion of water; for blue, water-blue BR, 5 B, or 2 B, in 200 parts of water; for green ink, methyl-green in crystals, in 100 parts of water; for a blue-black, aniline gray in 200 parts of water. A black ink may be made with soluble nigrosine in 200 parts of water.

DIMINISHING THE INFLAMMABILITY OF WOOD.

AN invention which, although primarily intended for another purpose, is likely to prove useful in preserving timber in mines and workshops, has been patented by Mr. G. R. McKenzie, of Glasgow. The invention may in practice be applied in different degrees in different cases, the resulting diminution of the inflammability of the wood treated being greater the stronger the solutions are that are employed, and the longer the duration of the treatment. A moderate application of the improved process, while materially diminishing the inflammability of wood, has also the important advantage, when applied to more or less green or new wood, of "seasoning," or, in other words, of effecting a change practically equivalent to that due to the ordinary process of seasoning, and the wood so treated can be subsequently turned in a lathe, or otherwise cut or shaped by means of tools such as are used for those purposes in ordinary wood. The invention consists in treating wood with soda crystals (monocarbonate of soda) in an improved manner, and in carrying it out the wood is by preference treated when in the sawn or cut condition, in the form of boards or joists, for example, rather than in that of thicker balks or masses.

When the object is to diminish the inflammability of the wood in a moderate degree at comparatively small expense, and yet secure the advantage of the "seasoning" effect accompanying the treatment, in the case of American ash, bay mahogany, and yellow pine in boards about ½ in. thick, he boils the wood under atmospheric pressure in a tank which is by preference covered in a solution containing about 2 lbs. soda crystals for each gallon of water. In arranging the boards in the tank they are "pinned" or separated by small pins or blocks, so that the liquid has free access between them, and the solution is filled in to a depth of about 6 in. above the top of the wood, or so that the wood does not become uncovered during the boiling process. The wood is held down by clamps, screws, chains, weights, or any other convenient means. The boiling should be continued for about 5 hours, and should then be discontinued for about 9 hours, after which the boiling should be renewed for about 2 hours. On the second boiling being completed the wood should be taken out of the tank as hot as it can be handled, and be "pinned" or piled with spaces between the boards or pieces in order to be dried, and this operation is to be effected without any extra heat, but by currents of cool air, and may be expedited by means of artificial or forced currents of air when conveniently applicable. In the case of the wood being about 1 in. thick the first boiling should be continued for about 8 hours, the interval be about 18 hours, and the second about 4 hours.

When the wood is about 2 in. thick the first boiling should be for about 10 hours, the interval about 30 hours, and the second boiling for about 6 hours. For white pine, pitch pine, oak, walnut, beech, elm, Spanish mahogany, and similar woods the strength of the solution should be increased to 3 lbs. soda crystals for every gallon of water, but the duration of the treatment may remain the same as hereinbefore prescribed for similar thicknesses of wood, it being, however, sometimes advantageous to soak the wood for some hours in the cold liquid before boiling. When the wood is 4 in. or more in thickness it should be boiled under pressure, and in a still stronger solution; thus, for example, a log of bay mahogany measuring about 20 ft. by 3 ft. by 2 ft. should be boiled under a pressure of about 80 lbs per square inch in a solution of 4 lbs. soda for every gallon of water, the first boiling being for about 20 hours, the interval about 60 hours, and the second boiling for about 10 hours.

When considerable diminution of the inflammability is desired, the strength of the solution should be from 3 to 5 lbs. soda for every gallon of water in the case of ½ in. white pine or 1 in. in yellow pine; and the wood should be soaked for about 12 hours, boiled for about 10 hours, soaked again for about 24 hours, and boiled again for about 5 hours. For similar thicknesses of oak, elm, or beech the solution should contain from 4 to 5 lbs. soda for every gallon of water. In the cases of 1½ in. white pine or 2½ in. yellow pine the wood should be soaked for about 20 hours, boiled for about 18 hours, soaked again for about 40 hours, and boiled again for about 8 hours. In the case of 3 in. by 6 in. white pine, or 5 in. by 12 in. yellow pine, the wood should be soaked for about 20 hours, boiled for about 20 hours, soaked again for a week, and boiled again for about 10 hours.

CEDAR WOOD.

THE cedar of Lebanon is the largest among the resinous trees of the whole world, and until it was discovered in Russia a century ago, it was supposed only to grow in Asia Minor. It is a native of the coldest parts of the mountains of Lebanus, Amanus and Taurus; but it is not now to be found in great numbers in either of those parts. Maundrell, in his journey from Aleppo to Jerusalem in 1696, could reckon only 16 large trees, although there were many smaller ones. One of the largest was 12 yards in the spread of its boughs. The forest of Lebanon never seems to have recovered from the havoc made by Solomon's four score thousand hewers, so that there are now probably more cedars in England than there are in Palestine. Its resistance to absolute wear is not equal to that of the oak, but it is so bitter that no insect will touch it, and it seems to be proof also against time. The timber in the temple of Apollo at Utica was found undecayed after a lapse of 2,000 years; a beam from the Oratory of Diana at Saguntum, in Spain, was carried from Zante two thousand years before the Trojan war.

Some of the most celebrated buildings of antiquity were constructed of this tree, foremost among which may be mentioned Solomon's temple, and the same monarch had a palace of cedar in the forest of Lebanon. Ancient writers noticed that the ships of Sesostris the Egyptian conqueror, one of them 280 cubits long, were formed of this timber; as was also the gigantic statue of Diana in the temple of Ephesus. Some difficulty, no doubt, exists with regard to the ancient history of this tree, there being other trees, still named cedars, which, though somewhat resembling them, do not belong to the same genus as the white cedar, which is a cypress, nor to the red, which is a juniper; but as they are commonly known by the name of cedar, it will be more convenient to describe them here as such. The few remaining stocks on Mount Lebanon are preserved with religious veneration by the Christians of that country. The patriarch of the Maronite Christians inhabiting Mount Lebanon, attended by a number of bishops, priests and monks, and followed by 5,000 or 6,000 devotees, annually celebrate, in their shade, the festival of the transfiguration, which is called the Feast of Cedars, and ecclesiastical anathemas are then denounced against those who shall injure these consecrated trees.

About the year 1680, cedar trees were brought to Europe and planted in the medical gardens of Chelsea. One hundred years afterwards two of them were upwards of 12½ feet in circumference at two feet from the ground, and spread their branches more than 20 feet in every direction. The red cedar, which belongs to the junipers, is the most common species of its genus in the United States, and the only one which attains such dimensions as to be useful in the industrial arts. The nearer the red cedar grows to the sea and the further southward, the better is its wood. The wood receives an exquisite polish, and Tunall mentions having seen a table made of heart wood which presented much variety of color. The cedar is said to be one of the highest timber trees in the island of Jamaica, affording very large board of a reddish brown color, close-grained, odoriferous, and offensive to insects, and the wood is, therefore, of great use to the cabinet maker. For ship-building purposes it is also valuable, and it makes excellent posts. It is eminently fitted for subterranean water pipes, when modern appliances are not to be had; but there is a difficulty in obtaining stocks of sufficient diameter.

The white cedar grows to a height of 45 or 50 feet, and sometimes more than 10 feet in circumference; usually, however, it is not more than 10 or 15 inches in diameter at five feet from the ground. From the number and distinctness of the concentric circles in stocks of this size, its growth must be extremely slow, as 117 have been counted in a log 13 inches and five lines in diameter. They are more compressed near the center, as in the cypress and white cedar, which is contrary to the arrangement observed in the oak, the beech, and the maple. The cedar abounds exactly in proportion to the degree of humidity, and in the driest marshes it is mingled with the black spruce, the hemlock spruce, the yellow birch, the black ash and the white pine. The full grown white cedar is easily distinguished by its shape and foliage. The trunk tapers suddenly from a large base to a very slender summit, and is laden with branches to four-fifths of its height. The principal limbs, widely distant, and placed at right angles with the body, gave birth to a great number of drooping secondary branches. The bark upon the body is slightly furrowed, smooth to the touch, and very white when the tree stands exposed. The wood is reddish, somewhat odorous, and very durable. It is softer than white pine, and gives a weaker hold to nails.

USE OF SOLUBLE GLASS IN THE TEXTILE INDUSTRY.

By H. GROTHE.

THIS paper was worked out by the author based on van Baerle's accounts regarding the prospects and practical uses which this substance at the present time affords to commerce.

1. *Soluble Glass used in the Textile Industry and in the Paper Manufacture. a. For domestic washing purposes.*—The action of this composition depends upon its rapid and energetic solution of the sweat and fat through which particles of dirt adhere to materials. It serves therefore not exactly for washing, but for loosening the dirt, by the energetic dissolving action of the soda. A hot solution of the composition also takes up sweat, fat, and tannin from the skin of the hands when the cloths are rubbed in it. Although the material is freed from sweat and fatty ingredients, its fibre and color is not attacked. This composition is used in the following manner: The article, without previous soaking, are placed in a lukewarm solution of the composition (a tub holding from 6 to 10 pails requires 1 lb. of composition), covered with a cloth or lid, and kept in this solution over night. The next morning the whole is stirred up with a stick and the dirty liquor ran off. The articles (linen or cotton, either colored or white) are then treated with a hot solution of 1 to 2 lbs. of composition, stirred up, taken out separately, steeped in a tub of lukewarm water, and if they show signs of dry dirt (fat or sweat no longer present), they are washed or brushed with common fat soap. Linen or cotton, if free from albuminous substances (blood, pus, nasal mucus), may at once be treated with a very hot solution of composition. Woollen and silk articles may be treated in a similar manner, using a warm solution for the former, and a lukewarm solution for the latter. Woollen articles do not shrink after this treatment. Colored woollen or silk articles are washed with lukewarm water; white woollen or silk materials with cold water, after having been previously pressed. Materials treated with soluble glass are always without smell, much cleaner, and never yellow in color.

b. For bleaching.—The use of soluble glass as a bleacher will become of great importance in the future. The author's experiments made in large bleach-works lead him to the conclusion as destined to supersede soda in bleaching operations. Substances like jute (Calcutta hemp), which hitherto could not be bleached without injuring their fibres, are bleached successfully by the following method: Jute materials are placed in a hot solution of soluble glass at 70—80° R. for 15 to 20 minutes (using 100 lbs. of water for 6—8 lbs. of soluble glass), and stirred up with a stick; they are then washed in hot water (not boiling), afterwards in cold water, bleached in a weak chlorine-bath, and lastly in an acid bath. Jute thus bleached will doubtless be available not only as a fine white pulp for the paper manufacture, but also for the manufacture of fine white spun goods. Instead of boiling hemp and cotton yarns for 6 to 8 hours in a concentrated soda solution, they need merely be moved about in a very hot bath of soluble glass for 10 to 15 minutes; 100 kilos. of linen yarn require 12—15 kilos. soluble glass, the cost of which is 50 per cent less than the 10 kilos. of 90° B. calcined soda solution generally used. All the baths may be used for three operations.

c. For finishing linen or cotton goods in place of China-clay.—Soluble glass is preferable for this purpose to China clay, as it is whiter in color, and can be formed by chemical reaction in the finest fibres of textures. In order to obtain the precipitate, a piece of linen or cotton is passed through a hot solution of alum and then through a hot solution of soluble glass, to which a small amount of glycerin is added. After this the material is passed through a weak starch-bath, and then through warm cylinders.

d. For impregnating.—Packing cloth, jute-mats, etc., may be rendered fire-proof, and materials used for covering waggons, tents, etc., may be made water-proof, by impregnating them with a solution of soluble glass.—*Chem. Centr.*

PREPARATION OF SOLUBLE GLASS FROM FOSSIL MEAL.

By F. CAPITAINE.

THE use of fossil meal for the preparation of soluble glass was proposed twenty years ago, but has not yet been adopted to any great extent, soluble glass being prepared in England where flint is cheap and abundant, by boiling flint in caustic lyes, and on the Continent by first preparing a glass by fusing sand, soda, sulphate, and coal, and then dissolving it in water pressure.

When flint is boiled with caustic lye of 1·25 to 1·3 sp. gr. for six to eight hours at a pressure of 4½ to 6 atmospheres, it yields a strongly alkaline glass, the proportion of alkali to the silicic acid being about 1 : 2. Fossil meal on the contrary, when boiled for three to four hours with lyes of 1·2 sp. gr. at a pressure of 3 atmospheres, gives a much more neutral product, the quantity of silicic acid which is three times that of the alkali. It is of course necessary to calcine the meal before treating it with caustic alkali, but as it is necessary to remove all traces of undecomposed organic impurities, the calcination process is rather long and troublesome. As the meal is now, however, brought into commerce in a calcined state and at proportionately lower prices, the author was induced to undertake a series of experiments on a large scale. He used caustic soda solutions of 1·22 to 1·24 sp. gr. An agitator was filled to about 60 per cent. of its volume with this solution, and calcined fossil meal added, using 1 part by weight of sodic hydrate to 2·8 parts by weight of pure fossil meal. The mixture was then agitated for three hours at a pressure of 3 atmospheres, and the operation, *i.e.*, complete solution of silicic acid, finished, when a portion from the agitator settled very quickly.

Too concentrated solutions, of sp. gr. 1·3 for example, gave unsatisfactory results, the clarifying process being retarded while the specific gravity of the product was too high. To obtain potash glass the boiling must be continued for 1—2 hours longer, and 10—15 per cent more meal used.

NEW MORDANT.

PERMANGANATE of potassium is rumored to have found a new way of being useful, namely, as a mordant for fixing aniline dyes in cotton and woolen stuffs. The stuff to be dyed is drawn through a chemically-pure solution of permanganate of potassium until it has become a clear brown color; it is then washed in cold water until the latter runs off free from color. The web is then drawn through a weak solution of acetate of tin, which removes the brown colors, after which it is subjected to repeated washings in water, then a dip in a tannin bath, and, finally, one in the

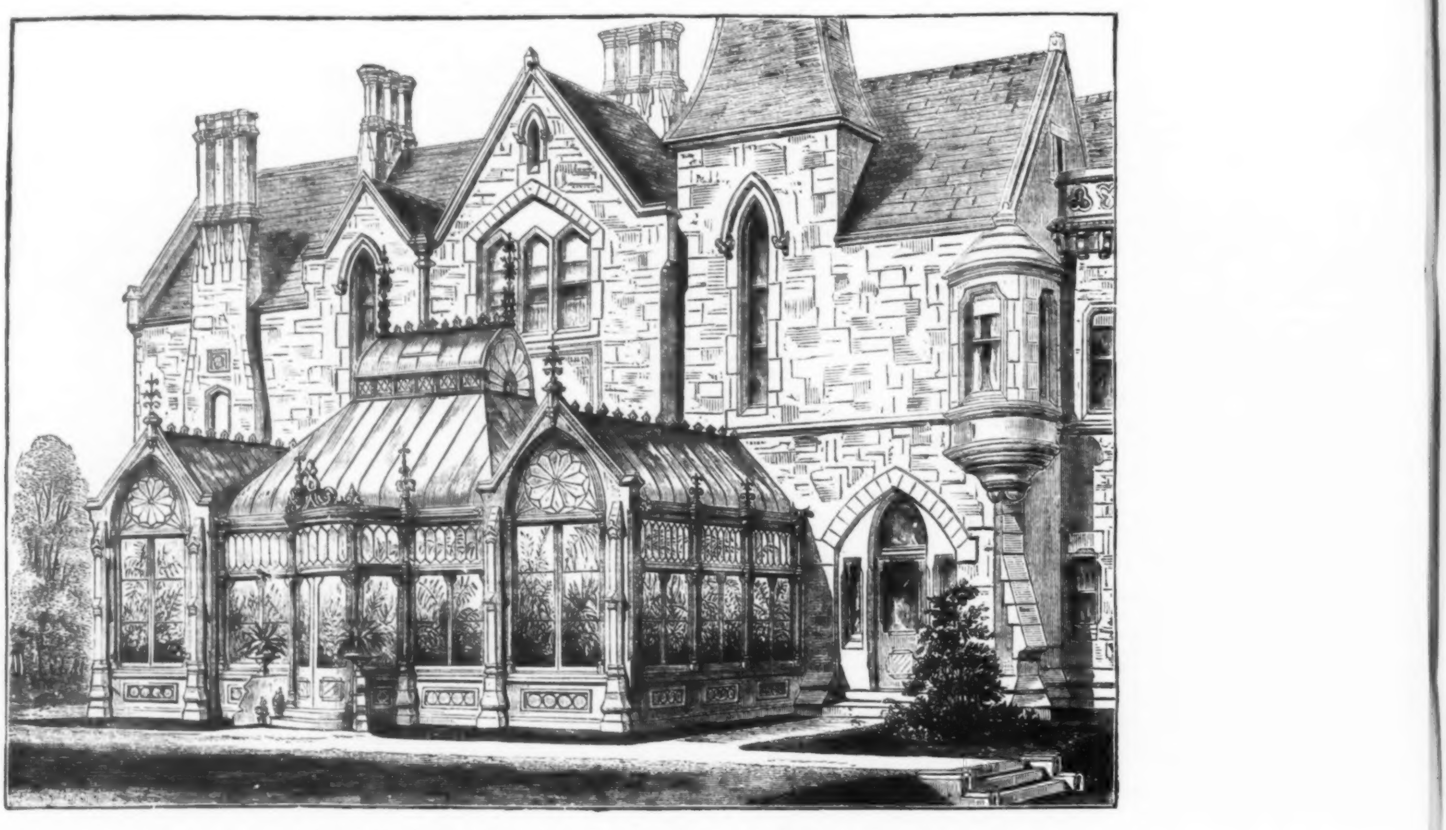
dyestuff. The great advantage of this process—especially for stuffs which are a mixture of cotton and wool—is that they can be dyed any color by means of a single dip in the dye tub. According to the *Correspondenz* this is the application of permanganate of potassium to which Herr von Stefanowski refers in his remarks on the toning of carbon prints.

VALUABLE RECIPES.

BLACKBERRY WINE.—To one gallon of mashed blackberries add a quart of boiling water; let it stand for 24 hours, or nearly so long, then strain through a coarse bag or towel, adding three quarts of water and two pounds of brown sugar to each gallon of the mixture, making equal parts of water and juice; mix well, then put in demijohns, stone jugs, or a tight, clean keg; close partially and put in a cool place; if in a warm place or left entirely open it will sour; if stopped entirely tight it will burst the vessel—but cork left loosely in; let it stand until fermentation ceases, which will be about October; then bottle, and this makes excellent wine and a fine medicinal drink for summer affections.

CURRANT WINE.—Squeeze the currants through a coarse bag; have equal parts of water and juice or one third water, as taste may direct, and add three pounds of loaf sugar to each gallon of the mixture; mix well and bottle in stone jugs or demijohns; treat same way as blackberry wine—partially corked and keep in a cool place. Some keep a bottle of the mixture to fill up the vessels as they effervesce, but it is not always necessary. Bottle in October, when fermentation ceases; this makes a beautiful and delicious wine, and improves with age.

GINGER POP.—Five pounds of loaf sugar to five gallons of cold water, four lemons, two ounces white root ginger, four ounces cream tartar; boil the sugar and ginger (previously pound the latter); when it has boiled fifteen minutes strain it through a flannel cloth into a large crock, put in the cream tartar, slice also the lemon into it; let it stand until milk warm, then add a teacup of yeast; let it stand a little, then bottle it tightly in stone bottles; in three days it will be fit for use.



DESIGN FOR A CONSERVATORY IN MIDDLE POINTED GOTHIC STYLE.

INK ON CARPETS.—I put salt on the stairs, and squeezed the juice from a lemon on the salt, and then washed with sponge and water drying with the sponge. It took out every vestige of stain without injury to the colors. This was done before the ink dried.

The above recipes are from the Ohio *Farmer*.

THE TRIAL OF THE PYX.

ON July 4, the annual trial of the pyx was held at the Goldsmith's Hall, London. The pyx is a box kept at the Royal Mint, in which the deputy-master is bound to deposit one coin out of every 15 lbs. of gold and 60 lbs. of silver coined by him. This year the pyx contained 900 sovereigns, 642 half-crowns, 460 florins, 1,019 shillings, 391 sixpences, 2 fourpences, 110 threepences, 2 twopences, and 6 penny pieces. The object of the trial of the pyx is to assure the country that the coin in circulation is in every way up to the standard. The trial consists of several stages. The jurors are first sworn by a special form of oath. The coins are brought in parcels by the Mint officers, and the number is checked by the jury. As many coins as are judged necessary are taken from each parcel, weighed, melted to an ingot, assayed, and compared with the "trial plates" in the custody of the Board of Trade. The next step is to weigh the remainder of the coins in bulk. As many coin as the jurors think fit are then taken therefrom, and each coin is separately assayed. The facts and results thus obtained are recorded in a verdict signed by the jury and the Queen's Remembrancer.

Two sovereigns taken as specimens differed from each other by only 0·3 grains, and varied from the standard by ·5 and ·8 grains respectively, while the degree of fineness varied from the standard by only ·36 per mille. The trial of two half-sovereigns showed an even closer approximation to the standard.

For the purpose of making this trial the following officers were summoned to attend from the various public departments interested in the proceedings, viz., the Queen's Remembrancer, Sir Frederick Pollock as President, the Deputy-Master of the Mint, the Hon. C. W. Fremantle, the Secretary of the Board of Trade, Mr. Thomas Henry Farrer, and the clerk of the Goldsmith's Company, Mr. Walter Prideaux. Twelve gentlemen, freemen of the Goldsmiths' Company, were summoned as jurors.

Their report was delivered to the President at 6.30 P.M. of the same day, and was afterwards published in the *London Gazette*.

IMPROVED STREET CARS.

THE John Stephenson Co., of New York, are building 50 new cars for Brooklyn city lines. They are thus described by the *Am. R. R. Journal:* The seats on the sides are of perforated wood and are broader and so inclined that the passengers will find them easy resting places. The framework of the flooring is laid in sections so that it can easily be raised or removed. Any person dropping money between the slats can easily recover it by raising the woodwork. The body of the car is handsomely varnished and decorated. All the railings and brake handles are silver plated. Besides the usual lights at the extremities the car is supplied with a large silver plated lantern in the roof, with a silver plated reflector. The bells, instead of being placed over the center of the platform as on the cars now in use, are attached to the sides of the roof. A twisted silver wire running along the side of car replaces the old-fashioned leather strap. Passengers desiring to alight have merely to strike the wire, instead of pulling it, the slightest blow rings the bell. The most important improvement is a wheel guard, securely fastened to the bottom of the vehicle and projecting above the wheels, almost sweeping the ground. It is composed of a strong and stiff bar of india rubber. The object of the guard is to remove all obstructions from the tracks without stopping. It is sufficiently strong to throw a child off the road, if it should be so unfortunate as to fall beneath the car. This will serve as a great safeguard to human life, and will relieve passengers of the unpleasant sensation occasioned whenever a car runs over a cobble stone or other obstruction. The 50 new cars will be distributed over the various lines where they are necessary to take the place of such as are worn out. The cars cost $1,000 each, the aggregate expenditure required being $55,000.

NEW METHOD OF PREPARING MUSIC PRINTING PLATES.

M. ALISSOFF, of St. Petersburg, states that at the present time there are two processes in use for the preparation of plates in the printing of music.

The first is like that used for the production of clichés for books, that is to say, the different signs or types used in musical typography have to be set one after another, so as to compose a complete musical stave. As each sign, however, is divided into several characters, this work is so long, and requires in the compositor so much practice and attention, that a cliché for music prepared according to this process is always very expensive.

The second process consists in engraving the notes on soft metallic plates. Although this is greatly facilitated and simplified by the use of special tools and punches, it requires in the engraver a particular skill, only to be acquired by well nigh life-long labor. And yet, even in the hands of the most skillful engraver, it progresses very slowly, as mistakes can only be avoided by the most extraordinary attention. It is difficult to correct minor errors, and those of greater importance—as, for instance, an omission, or a defective arrangement of the bars—is irreparable. In that case there is no alternative but to begin the whole page over again.

The composing process I employ for the printing of music greatly simplifies and accelerates the work.

It may be described as follows:

Firstly, the staves, notes, and other signs used in music are printed on very thin unsized paper, and arranged in type cases like ordinary metallic types. This done, the composition is set by simply pasting, first the staves, then the notes and signs, on a sheet of glass in accordance with the manuscript which is to be printed. These different characters have to be affixed to the glass with a gum which has the property of rendering the paper transparent. As a guide to the compositor, I place on the opposite side of the glass a sheet of paper, ruled closely with vertical and horizontal lines, with the aid of which it is very easy to space the bars properly, and to dispose the notes and musical signs on the staves with perfect regularity. Moreover, the characters made use of, being three or four times larger than ordinary musical signs, may be handled with great facility. When a page is set, the ruled sheet of paper is removed from the glass, and by means of photography (letting the light pass through the composition) a negative is taken, reducing the page to the desired size. From this negative it is easy to transfer the composition to stone, and to print, according to the usual photo-lithographic process, any number of copies required.

Should clichés be wanted, the composition would have to be transferred to zinc plates, prepared according to the ordinary method of helio-engraving.

The advantages of this process are the following:

1. The work of composition for music is simplified to such a degree that no special compositors or engravers are needed; any one, even a child, may do it, after having but once seen it done. I may even say it is no longer a man's work, but rather a woman's.

2. When composing, any correction whatever may be made with remarkable facility and rapidity; the composer has but to unpaste the little piece of paper on which the error has been made, and he is thus under no necessity of beginning the whole page over again.

3. With the same composition stereotypes of any size whatever may be obtained.

4. A page of music printed by this process, far from being less perfect, is even superior to one printed by the ordinary method.

5. A person establishing a printing office according to my plan will avoid the considerable expense commonly incurred in the purchase not only of a stock of metallic signs and characters, but also of engraver's tools and punches.

6. This process may be used with success for the printing of titles in fancy letter, and ornamented with vignettes, and even for the printing of all names and words of maps and plans.

INDIAN CORN.

IN England corn is an almost unknown article. Here is what an intelligent Englishman writes to a London paper concerning a cereal that forms the largest crop in this country or in the world; in growing which forty-four millions of acres of ground are annually cultivated here. The writer says:—

A short time ago there was a question asked about cooking this, and in the answers I have only seen parching it spoken of. Now, one good way of cooking it is to boil the heads while green, and eat them with a little butter, pepper and salt; but for the ripe corn I do not think any way is better than that almost daily employed by the natives at the Cape. They use a large deep wooden pestle and mortar, in which they beat the ripe corn for some little time.

This loosens and breaks the skin. The corn is then put into a basin of cold water, when the skin swims at top, and

is poured off. The white corn is then boiled till tender, and eaten with butter, or mixed with milk and eaten with sugar. When well done it makes a very nice dish. While writing about Indian corn, it is a good deal used now for horses and pigs, but I find most people give it whole, and with the skin. This is a bad plan, as it is not well chewed, and the skin being very hard and flinty it injures the teeth very quickly. I used always to use it, and it makes capital food and cheap for a horse or pig, but it should always be boiled.

DESIGNS FOR CONSERVATORIES.

HORTICULTURAL builders have to study not only the requirements of plant-growers but of architects. Conservatories intended to form part of the features of a mansion should obviously be in accordance with the style of the building, and as these structures are primarily designed for show-houses rather than for houses wherein to grow plants, their suitability to the latter purpose is for this point of view a matter of secondary consequence. The accompanying designs prepared by Messrs. Weeks & Co., of London, given in *The Gardeners' Chronicle*, show how well the horticultural builders can adapt their structures to architectural requirements. In the one case we have a conservatory in the style of Queen Anne, while the other is a Gothic design of Middle Pointed style.

DESIGN FOR A CONSERVATORY IN QUEEN ANNE STYLE.

THE ZINC MINES OF LANCASTER COUNTY, PA.

THESE mines are situated about five miles west of the city of Lancaster and about twelve hundred feet south of the line of the Pennsylvania Railroad. The country rock in which the ore is found is the Auroral or Trenton limestone, or the same as that in which the Friedensville mines, near Bethlehem, are located.

The ores as originally discovered had been oxidized to the condition of calamine, which, however, at depths varying from twelve to fourteen feet, were unaltered blendes in limestone. In 1847 the calamine ores were treated in Wetherell furnaces for the production of zinc oxide, but these ores not lasting very long, and the attempt which was made to use the blende for the same purpose having failed, the works were allowed to fall into decay. Desultory workings have from time to time been carried on there, and finally in 1874 Messrs. Bainford Bros., of England, purchased the mines, and under their direction have been systematically opened. Two beds of the blende-impregnated limestone have been found and worked, their direction at the surface being nearly parallel with each other, and having a strike of N. 74° E., with a slight dip to the east and an underlie to the north. The two beds are separated from each other at the surface by about thirty feet of limestone, but as the south vein dips toward the north vein it is probable that the two veins come together at some distance below the surface. The north bed averages about twenty-four feet in thickness, and it is separated from the inclosing limestones by well-defined lines of parting. The workings have been carried to a depth of 96 feet, the principal galleries, however, being 56 feet from the surface and 200 feet in length from east to west. The south bed is about 16 feet wide, and has only been explored to a depth of 56 feet by a drift from the workings in the other bed. Near the hanging wall of this south bed considerable quantities of argentiferous galena, tetrahedrite, and carbonate of lead have been found in small lenticular masses, and thin veins imbedded in the limestone.

These ores are quite rich in silver, some specimens assaying over $2,000 per ton, the average richness being about $150 per ton. The western extremity of both the ore beds seems to have been reached in the present workings, but to the east what is apparently the continuation of the same beds has been cut through by the Reading Railroad, three miles distant from the mines.

The great obstacle in working, mine water, which has at last caused the abandonment of the Friedensville mines, is not present at any quantity in these mines, a 16-inch x 3-foot single acting plunger pump being abundantly able to raise the water yet found. The ore after being raised through a shaft is hand-sorted, so that when carried to the adjacent dressing floors it contains about 12 per cent of metallic zinc. The dressing floors are arranged so that the ore is carried from the top of the building by gravity through all the processes of separation. A Blake's crusher and Cornish rolls crush the ore, which, after passing through classifying trommels and reparators, is carried to six sets of "Hartz" jigs, having four plungers each, in which the separation of the blende from the limestone is effected. The slimes are separated in three ordinary buddles. The total capacities of the floors for dressing are about 40 tons of the raw ore per day. The blende, which is manufactured into spelter, is then carried to the main furnace building, which contains two single hearth and two double hearth roasting furnaces and four sets of Belgian reduction furnaces. The ore is roasted 24 hours in the reverberatories, the final heating bringing it to a nearly "dead" condition. Each of the four reduction furnaces holds 56 retorts, which are heated by anthracite coal and blast. The charged retorts in each set hold about 1¼ tons of ore, which is mixed with one-third its weight of pea coal and a little salt.

The charging and reduction take about 12 hours. About ½ ton of zinc is produced in each furnace per shift of 12 hours. Belgian, French, German, and Spanish workmen are employed as smelters, the long apprenticeship necessary for learning to properly manage the furnace having kept American workmen from acquiring the process up to the present time. The retorts used are made at the works, and are composed entirely of Amboy clay. They have an average life of 18 heats, those in the upper part of the furnaces lasting much longer than those nearer the fires.

It will have been noticed from the foregoing description that the dressing floors have a capacity much greater than the reduction furnaces, and it is proposed to erect 12 more of the latter, thus increasing the yield of spelter to about four tons per day. The following estimate of the cost of production based upon this increased capacity is made by Mr. E. Gybbon Spilsbury, general manager of the works:

Cost of mining 40 tons of ore a day at $1.00	$40 00
Transportation to dressing floors	2 00
Dressing 40 tons, less weight ⅓ = 26.63 tons dressed.	20 00
2 engineers at $1.50	3 00
2 tons of hard coal at $2.38	4 76
Labor in roasting 26.63 tons at $1.00 per ton	26 63
Fuel, 26.63 tons at $4.00	106 52
Labor to reduce, say 24 tons calcined ore, say 18 shifts, at $9.00 per shift	162 00
Fuel for reduction in furnaces, 25 tons at $2.38	59 50
Fuel used for reduction in retorts, 7½ tons at $1.50.	11 25
Retorts used, 54 at 75c	40 50
Condensers used, 180 at 2c	3 60
	$479 76
10 per cent. of above for wear and tear and general management	47 98
	$527 74

Zinc produced would be at least possible estimate 9,900 lb. Dividing the above cost by this number of pounds would give $4.75 as cost of zinc per pound. The following analysis shows the quality of the spelter produced:

Zinc	99·687
Cadmium	·034
Lead	·262
Copper	trace
Iron	·017
	99·998

The total production of spelter is at present from 15 cwt. to 20 cwt. per day of 24 hours. The silver lead found is not treated at the works, but is shipped to Balback's Works at Newark, N. J., for separation.—NICHOLLS, in *Eng. & Min. Jour.*

FLUE DUST

WE paid a visit to the Lemmon mill and, by the courtesy of Mr. Clark, were shown through the institution. The mill was built a number of years ago, for the purpose of reducing the free ores in this vicinity, but for some reason, probably because it failed to pay, has been idle for a long time. Messrs. Clark & Wallace effected a lease of the mill about a month ago, and since that time have been busily engaged in renovating and repairing the machinery, and getting it in order to work the flue dust purchased by them of the Consolidated company. We have given an account of the discovery of the process by Messrs. Clark & Wallace and the wonderful results obtained in experiments at Salt Lake. They concluded that the dust could be worked at this point more profitably, saving, as it would, the items of sacking and freight. The Lemmon mill is a dry crusher, provided with a White roasting furnace, a battery of 15 stamps, pan, concentrators, agitators, etc. Several modifications and improvements have been introduced by the lessees, notably in the battery, the speed of the stamps having been increased from 70 to 90 drops per minute, and the drop reduced from nine to six inches. The stamps will not be used in the working of the flue dust, but it is the intention of the owners to crush any free ores that may be offered to them. A large bin at the rear end of the mill receives the dust and conveys it to the drying floor, where all of the moisture is evaporated. It is then received in a sheet-iron receptacle, where it is mixed with salt and conveyed to a series of belts that carry it to the hopper over the furnace. As above stated, the roaster is of the White pattern, a system that is generally used in Nevada county, California. It would occupy too much space to attempt to give the workings of the furnace; suffice it to say that by the time the charge reaches the delivery floor it is thoroughly roasted and ready for the pan amalgamation. The pans in the mill are of the Horn pattern, and are not adapted to give the best results, but will be used for the present. Their concentrators are also old-fashioned but their defects will be remedied by careful manipulation. Larger pulley blocks have been placed on the part of the shafting, increasing the speed of the mullers. The engine has been overhauled and put in good order, and also the retorts. The old swimming bath south of the mill has been repaired and will be used as a source of water supply for the present. The tank on the hill has been caulked and the pumps were at work yesterday filling it. Negotiations are pending with Major McCoy, looking to the extension of the main to the mill tank on the hillside. The mill will start up on Monday for a permanent run. Messrs. Clark & Wallace are not given to boasting, but it is easy to see by their actions that they are convinced of the future success of their enterprise—a good fortune that we heartily wish them. The town, as well as the owners, will benefit by the profitable workings of the dust.—*Eureka Sentinel.*

OXYGEN IN STEELS.

By SERGIUS KERN, St. Petersburg.

ENGINEERS making cast steel by the Bessemer process know very well the following two facts:

1. That on adding, to the metallic bath in the converter, melted spiegeleisen a very high flame rises from the mouth of the apparatus, which is, first, of a very white color, and next gradually changes, the flame becoming crimson when all the spiegeleisen has been poured in and the retort is turned to the casting ladle. It must be mentioned that during all this time there is no blowing through the apparatus, so that no abundant quantity of oxygen can be supposed to be present in the apparatus; however the flame mentioned above is of a very oxidizing character.

2. As the metal in the apparatus is thoroughly decarburized, which may be easily ascertained by the spectroscope, and as the percentage of carbon in the spiegeleisen coming from the cupola may be strictly determined, it is evident that the percentage of carbon in the obtained steel may be very easily and exactly predicated. However, in

the resulting steel a lower percentage of carbon is always found than ought to be, according to the calculations of the metallurgist; but a higher percentage in this case was never determined—certainly in this case the process must be very accurately executed.

This is still an open question in metallurgy. Leaving to the metallurgists the study of these interesting facts, I merely mention here that some chemists explain this metallurgical point by the occlusion of oxygen in melted steel, and some of them tell us that even solid steel contains oxygen in very minute quantities.

At the moment when the spiegeleisen is added to the metallic bath, a certain quantity of the carbon which it contains combines with the occluded oxygen, forming carbonic oxide (CO), which flies away, giving to the hot gases coming out from the retort a crimson tint; indeed, carbonic oxide, burnt in sufficient quantity, imparts to the flame a crimson tint. In such a case, when a certain quantity of carbon is burnt, the resulting steel must contain less carbon than was expected.

In order to ascertain the presence of oxygen combined with the steel in the metallic bath of the Bessemer apparatus before the addition of spiegeleisen, several experiments were made. As no special method for the determination of oxygen in steels could be found in manuals of analytical chemistry, a very easy method was devised which, noticed here, may be of some use to chemists for further experiments:

100 grms. of the steel in pieces weighing 10 to 15 grms. are placed in a platinum or porcelain combustion tube, connected with a potash apparatus containing a freshly prepared concentrated solution of pyrogallic acid—

$$[C_6H_3(HO)_3]$$

in potassium hydroxide. The potash apparatus before the experiment is carefully weighed on a delicate balance. Next the combination tube is gradually heated to a high temperature. In the same time through the tube and apparatus nitrogen is passed, obtained by the decomposition by heat of ammonium nitrite (NH_4NO_2). Before passing this gas through the apparatus it is well dried by calcium chloride. The ignition of the steel in the tube must be continued for an hour, and next the apparatus is gradually cooled; the nitrogen meanwhile is also freely passed in order to avoid oxidation. The potash apparatus is next quickly weighed. The increase in weight of the apparatus will show the quantity of oxygen present in steel.

Experiments proved the existence of oxygen in very moderate quantities. Thus five specimens analyzed gave 0·054, 0·037, 0·025, 0·040, 0·031 per cent. of oxygen.

It would be of great interest if chemists undertook experiments in order to work out this question. My opinion is that in this case the oxygen is in an occluded state with steel, and even forms a certain chemical compound, very unstable, however, when heat is applied. It may be analogous to hydrogen palladium (Pd_2H), which, by some chemists, is regarded as a chemical compound, and by others as a simply mechanical compound of palladium and hydrogen, the latter being only occluded in the metal.—*Chemical News.*

FREEZING MIXTURES.*

THE numerous and varied applications which ice has found in these times have greatly enhanced the importance of that product, and while large portions of it have annually been transported from the colder to the hotter regions of the globe, scientific ingenuity has attacked, energetically and successfully, the problem of producing cold by artificial means for industrial and other purposes. In a recent number of *Dingler's Polytechnisches Journal*, Professor Meidinger has an instructive paper giving an account of the progress made in recent years in the art of ice manufacture.

There are three ways indicated by physics in which temperature may be lowered, and ice formed, viz., solution of solid substances, evaporation of liquids, and expansion of gases. The following is an abstract of that portion of Professor Meidinger's paper relating to production of *cold by solution*:

Heat is absorbed in bringing solids to the liquid condition; and the cold thus produced may prove sufficient to convert water into ice.

The best known of the numerous freezing-mixtures that have been hitherto described is, of course, one involving ice itself; it consists of three parts of ice, and one part of ordinary salt.

Dissolving concurrently, these two substances give a temperature of —21° C. (the freezing point of the solution). The melting of only a part of the mixture is sufficient to produce this temperature throughout the mass; and with constant admission of heat, and stirring, the low temperature is maintained till the whole is dissolved. The freezing-apparatus of confectioners is well known: a tin pot containing cream, a wooden or metallic vessel inclosing the pot, and the interval filled with ice and salts, which is frequently stirred, that the ice may not sink to the bottom. In a Paris machine for home use the agitation of the freezing mixture is maintained by rotation of the double cylinder containing it and the cream vessel round an axis at right angles to the cylinder's length. Professor Meidinger has constructed a machine based on the observation that a solution of ordinary salt under 0° also fuses ice, and, so long as its concentration is maintained, produces the same low temperature as the mixture of salt and ice. He provides a sieve-like vessel, containing salt, to maintain the concentration as the ice melts. The lowering of temperature is uniform throughout the vessel, and no stirring is required. The machine has come largely into use in perfumery.

On the basis of his own experiments, Professor Meidinger has formed a table showing the respective merits of various freezing mixtures. The following extract contains the most serviceable:—

Mixture.	Decrease of temperature.	Specific heat of the solution.	Volume weight of solution.	Loss of heat units. 1 k. Mixture.	Loss of heat units. 1 l. Mixture.	To use for 120c. Salt k.	To use for 120c. Water k.	To use for 120c. Cost in Marks.
1 ordinary salt, 3 ice	21°	0·83	1·18	125	100	0·5	1·5	0·34 to 0·12
3 cryst. Glauber salt, 2 concd. muriatic acid	37°	0·74	1·31	55	74	2·7	1·8	1·0 to 0.6
2 nitrate of ammonia, 1 sal ammoniac, 3 water	30°	0·70	1·20	42	51	3	3	7·6 to 6·8
3 sal ammoniac, 2 saltpetre, 10 water	26°	0·76	1·15	40	46	2·1	4·2	2·6 to 2·2
3 sal ammoniac, 2 saltpetre, 4 cryst. Glauber salt, 9 water	32°	0·72	1·22	50	61	2·5	2·5	1·8 to 1·6

Salt mixtures give much greater lowering of temperature than simple salts, as they dissolve in much less water. Thus one part sal ammoniac is dissolved in three parts water, and lowers the temperature about 19°; saltpetre dissolves in six parts water, and lowers the temperature about 11°. (Compare the fourth and fifth on the list.) It will be seen that the salt-ice mixture proves considerably more energetic and cheaper than any of the others so far as use of the materials only once is concerned. The second mixture, too, cannot be restored; nor can the last, easily, on account of the crystallized Glauber salt. Both are comparatively cheap, however. The mixture in which, by vaporization of the solution, the salt is easily renewed in its original condition, nitrate of ammonia and sal ammoniac, is so costly at the first that it would not do to use it only once. This was the mixture employed in an apparatus first exhibited by M Charles at the Paris Exhibition in 1867. The tin vessel containing the substance to be frozen is inclosed in a large wooden vessel containing the freezing mixture, and is furnished with screw wings, which stir the mixture as the vessel is rotated. Another form is that of Toselli's glacière Italienne roulante. The cream or other such substance is enclosed in a conical-shaped vessel suspended in the freezing mixture, and the outer vessel, enveloped in cloth, is rolled to and fro on the table. None of these machines have found very extensive use. Large masses have to be operated with to obtain even small results; and the sum of operations must generally prove too troublesome in a private house.

As to the question of manufacturing ice on a large scale by means of solution of salt, Professor Meidinger comes to the conclusion that by means of 1 kilog. of coal (for restitution of salt used not more than 2 kilogs. of ice can be prepared; not to speak of the machine force required for transport of the large quantity of liquid. This is very unfavorable; an ammonia machine will give four or five times better results. Much improvement is, in the circumstances, hardly to be looked for. It would be necessary to find a salt that, in dissolving, gave a much greater lowering temperature than the mixtures known, and this cannot be expected, since all the known salts have been examined in reference to this point. The real cause of the small productions of such apparatus lies in the fact that restitution of the salt is effected only by change of aggregation (vaporization), and this involves large expenditure of heat. It may be mentioned that, according to experiments by M. Rudorff, on cold produced by solution of twenty different salts, the two which gave the greatest lowering of temperature were sulphuretted cyanide of ammonium, and sulphuretted cyanide of potassium—105 parts of the former dissolved in 100 parts water produce a lowering of temperature of 31·2°; and 130 parts of the latter in 100 parts of water as much as 34·5°.

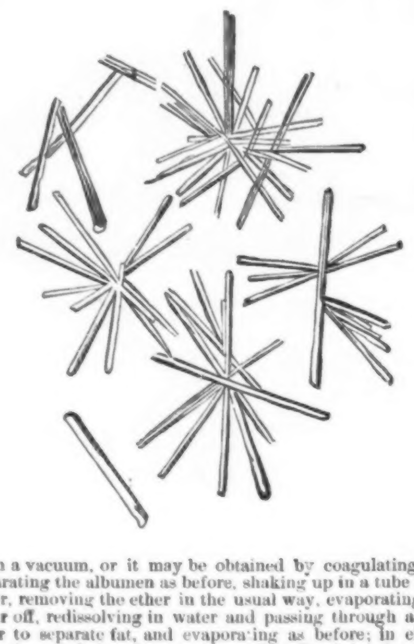
* English Mechanic.

CRYSTALS OF COBRIC ACID.

BEING THE MICROSCOPICAL ACTIVE PRINCIPLE OF THE COBRA POISON.

AN interesting paper in which the chemistry of cobra poison is exhaustively dealt with appeared lately in the *Analyst.*

The accompanying representations are figures magnified 230 diameters of cobric acid, of which the following account is taken from an essay by Mr. W. Blyth, M.R.C.S., that appeared in the *Analyst*: "On the 1st of January of this year I succeeded in obtaining a crystalline, acid, extremely poisonous substance, which appears to be contained in the venom to the extent of 10 per cent.; this substance, there is every reason to believe, is the sole and only active principle. It may be obtained by coagulating the albumen with alcohol, filtering, driving off the alcohol at a gentle heat, concentrating the liquid to a small bulk, precipitating with basic acetate of lead, collecting the precipitate, washing it, and subsequently decomposing it in the usual way by SH_2, removing the sulphite of lead, evaporating to a small bulk at a gentle heat, and finishing the evaporation spontaneously



or in a vacuum, or it may be obtained by coagulating and separating the albumen as before, shaking up in a tube with ether, removing the ether in the usual way, evaporating the ether off, redissolving in water and passing through a wet filter to separate fat, and evaporating as before; in either case the result is microscopic needles, dissolving in water with an acid reaction and possessing highly poisonous properties; they appear to be identical with the needles obtained by sublimation.

"For this substance I provisionally propose the name of cobric acid. I have not been able to go, as yet, any farther in the investigation of this interesting substance, for the simple reason that my two very small supplies are now exhausted, and I must wait for a third packet; but it will not be uninteresting to pause for a moment to consider what a terribly active substance this cobric acid must be, for supposing Nicholson's data are correct, and that the whole of the average quantity of the venom (that is 6 grains, containing 2 grains of solids) is injected into a man, it then follows, since the solid residue contains 10 per cent. of cobric acid, that one-fifth of a grain would be fatal, so that we have here a rival to aconitia, weight for weight, in its power of destruction.

MANUFACTURE OF ALUM.

THE invention of Messrs. P. and F. M. Spence, of Manchester, consists in treating shale for the production of alum by adding the requisite quantity of acid at once to a charge of the said shale, and subsequently transferring it successively to other charges. Thus they use three vessels to which shale is supplied, and add to the first the whole quantity of acid to constitute an equivalent for all the alumina and other bases to be extracted from a full charge. After this has been boiled for a sufficient time the solution is removed, and transferred to the second vessel containing shale, and after digestion to the third vessel, and after digestion therein the liquor is run off for the manufacture of alum. The first vessel having been emptied is again filled, and the second of the series has now a full charge of acid boiled upon the shale therein, the solution being then transferred to the vessel from which the finished liquor has been run. After boiling here it is transferred to the refilled vessel, which now becomes the third of the series, and thus the process goes on, the pan which has been for digestion with the fresh charge of acid being the one to be emptied and refilled. Thus the fresh acid is digested upon the partially exhausted shale, and extracts as much as possible of its alumina, while the partially saturated acid is digested upon the fresh shale, and is thus all, or nearly all, taken up. Sometimes two instead of three vessels may be employed; or if the solution is desired to be entirely neutral or "sweet," then if it should prove necessary more than three may be used. In like manner they use the series of digestions for the production of the ordinary and basic alumino-ferric compounds from bauxite or shale, or from both.

RUSSIAN SCIENTIFIC NEWS.

PALLADIUM.—At a recent meeting of the Russian Physical Society, M. Gesechus made some remarks on the elasticity of metallic palladium. Preliminary experiments showed the coefficient of elasticity to be 16,100 (platinum = 17,000). Hydrogenated palladium (Pd_2H) has a rather lower coefficient =14,400; this number remained the same even after three or four days, when a certain quantity of hydrogen was liberated. The diminution of the palladium wire could be observed for more than ten days.

ELECTRIC LIGHT.—M. Tchicaleff has executed during last winter interesting experiments on the intensity of the electric light in the open air. Magneto-electric machines of Altence were used. The eye could not detect much difference in the lights of two machines—one equal two 1c,000 candles, the second 4,000 candles—notwithstanding that in the first case a refractor was used and in the second a reflector. During these experiments the advantage of carbon candles covered with galvanic copper was again proved; ordinary carbons burned for a length of 0·07 metre, while the carbons covered with copper burned for a length of 0·01 metre.

SOAP.—M. Grabowsky, of Kazan, has made some experiments with soap manufactured in Russia, and obtained the following results:

1. Soap prepared from oleic acid contains less water than soap manufactured from solid fats (stearic acid).
2. With the decrease of the melting-point of the acids used in soap manufacture the dissolving power increases.
3. In soaps prepared from solid fat acids more than a third by weight is lost without any use when the soap is used for washing purposes.

At the same time the author proposes to use solid fat acids for the manufacture of candles, and the oleic acid for the preparation of soap; the resulting soap is easily soluble in water.

PETROLEUM.—A peculiar hypothesis has been proposed by Professor D. J. Mendeleef on the formation of naphtha in nature. In sandstones, where a great quantity of mineral oil is often found, there is no presence of organic deposits or of great quantities of coal or lignite. The author thinks that in all cases it is difficult to suppose that the formation of naphtha is due to the destruction of organic matter. M. Mendeleef explains the formation of naphtha by by certain reactions of mineral substances, viz., metallic carburets. In the interior of the earth abundant quantities of metallic carburets are supposed to exist, which, by the action of water under high pressure and temperature, give metallic oxides and primary hydrocarbons (C_nH_{2n+2}). The hydrocarbons volatilize and condense in the superincumbent sandstones, which are spongy enough to condense great quantities of the mineral oil. Numerous experiments have been commenced by the Professor, which, when finished, will have a high interest for the chemist and geologist.—SERGIUS KERN, *in Chemical News.*

DEUTSCHE CHEMISCHE GESELLSCHAFT, BERLIN, JULY 9th, 1877.

Professor C. LIEBERMANN, Vice-President, in the Chair.

DR. F. TIEMANN and P. Koppe exhibited and described an "*Apparatus for the Determination of Free Oxygen in Water,*" being essentially a simplification of Schutzenberger's method. It consists of a flask from which the air can be expelled by a stream of hydrogen, connected with two burettes. One contains a solution of indigo and the other a solution of hydrosulphite of soda. The strength of the latter solution is obtained by comparison with a normal solution of a cupric salt. After expulsion of the air from a flask, a given quantity of the indigo solution is admitted, and sufficient hydrosulphite of soda added to decolorize the solution. A measured quantity of the liquid containing free oxygen is then admitted. The blue coloration which ensues is then removed with the solution of hydrosulphite, the amount required corresponding to the amount of oxygen present. A moderate temperature is maintained during the operation. The process yields very accurate analytical results.

C. O. CECH describes a peculiar "*Action of Taurin in the Organisms of Birds.*" It has already been noticed that taurin in the human and canine organisms changes into the corresponding uramido acid, while in the urine of rabbits it gives rise to hyposulphurous and sulphuric acids. The author finds, on the contrary, that in birds which have been fed on taurin, a notable increase in the amount of H_2SO_4 takes place, unaccompanied, however, by uramido, hyposulphurous, or sulphurous acids. In order to explain the decomposition of the taurin urea was sought for, but in vain. A large increase in the amount of uric acid was, however, noticed, leading to the conclusion that the urea formed by the decomposition was changed in the organisms of birds into uric acid. This assumption was confirmed by feeding

fowls on urea, observation showing that the urea was changed completely into uric acid during the passage through the organism.

THE same author describes the *Preparation of Dichlor acetanilide*, which he obtains from dichloracetic acid and aniline by digestion with phosphoric anhydride, and from ethylic dichloracetate by first changing it into the amide and then digesting with aniline.

NEW DERIVATIVE OF INDIGOTIN.

By P. SCHUTZENBERGER.

THE following results have been obtained with pure indigotin, prepared by agitating an alkaline solution of white indigo in contact with air: It was then heated in a closed vessel to 180 C., with twice its weight of the crystallized hydrate of baryta, $1\frac{1}{2}$ times its weight of powdered zinc, and 10 times its weight of water, for 48 hours. At the outset there was formed an alkaline solution of white indigo, a true vat; but after two days of heating the liquid on exposure to the air ceased to yield blue indigotin. At the bottom of the autoclave was found an insoluble powder, chiefly mineral, and consisting of zincate of baryta, carbonate of baryta, and zinc in powder. This residue yields to alcohol an organic substance which gives a brown color to the solvent. On evaporation to dryness this alcoholic solution leaves an amorphous resinous residue of a deep color, brittle in the cold, but becoming soft under 100°. This residue was mixed with zinc powder, and the mixture heated by portions of 10 grms. in a small porcelain crucible, set in a sand bath and heated by a Bunsen burner. The crucible was covered with filter paper, upon which rested the lid. The interior of the crucible then became lined with long and beautiful crystalline needles of a light yellow, resembling sublimed anthraquinon. They are fusible at 245°, insoluble in water, soluble in ether or alcohol, to which they communicate a bluish fluorescence. On analysis they give numbers agreeing exactly with a polymer of indol $x(C_8H_7N)$. The new body has well defined basic properties, and forms crystalline compounds with acids. The author has given it the name indolin. It dissolves in hot dilute hydrochloric acid, and the solution forms with platinic chloride a yellow, granular, crystalline precipitate. Concentrated sulphuric acid dissolves indolin with a blue fluorescence, and the solution on exposure to the air deposits—as it becomes hydrated—yellow crystalline grains of indolin sulphate. Indolin sublimes sometimes in needles resembling anthraquinon, sometimes in leaflets like anthracen, but always leaving a carbonaceous residue.

CUPREOUS COMPOUNDS IN THE STOMACH AND BLOOD.—V. Feltz and E. Ritter.—Insoluble albuminate of copper introduced into the stomach has scarcely any effect on the system. The soluble albuminate occasions affections fully as severe as those produced by the ammoniacal sulphate in distilled water. Sulphate of copper dissolved in syrupy glycerin is much more poisonous than the same salt dissolved in aqueous glycerin. A solution of albuminate of copper containing 0·00115 grm. of copper per c. c. occasions death as soon as the dose introduced exceeds 0·0015 grm. per kilo. of the weight of the animal. A salt of copper introduced into the stomach does not become poisonous until the system has absorbed the quantity just mentioned as proving fatal in the blood. The chief channels for the elimination of copper, placed in the order of their importance, are the bowels, the liver, and the kidneys.

A REMARKABLE VEGETABLE POISON.

IN consequence of the impression that acts of poisoning are associated with the increasing belief in witchcraft in Jamaica, the Government has appointed a chemist, Mr. Bowrey, to investigate the vegetable poisons of the Island. One of the plants examined by Mr. Bowrey has been the *Echites suberecta*, from which he has obtained an alkaloidal salt, one thousandth part of a grain of which is capable of poisoning a cat. The operation was a very unpleasant one in consequence of the pain caused when small particles of this substance came into contact with the skin.

PREPARATION OF CHEMICALLY PURE GRAPE SUGAR.

By C. NEUBAUER.

FINELY powdered refined cane sugar is added to 500 or 600 c.c. of alcohol of 80 per cent., containing 30 or 40 c.c. of fuming hydrochloric acid, and the liquid, poured off from excess of sugar, is set aside in a closed vessel.

Crystals of grape sugar are soon deposited; these are collected on a filter, washed with alcohol until free from acid, and dried by exposure on porous paper. The dry substance is recrystallized from boiling absolute alcohol. By adding a further quantity of powdered cane sugar to the acid mother liquors, a second crop of grape sugar crystals is obtained.

ALCOHOL FROM SUGAR CONTAINED IN BEET LEAVES.—M. Pierre takes 347 lbs. beet leaves, cuts them into fragments, and pounds them in a mortar until from 34 to 35 quarts of juice are extracted. This is left to ferment with a couple of pounds of beer yeast at a temperature of about 48° Fah. After five or six days the juice is filtered through cloth, being previously heated for a few minutes to 176° Fah., in order to coagulate a part of the albuminoid matter. This liquid is finally submitted to several successive and methodical rectifications, which furnish 1677·5 cubic inches of alcohol at 68° centesimal plus 823·5 cubic inches of water at 80°.

EXTRACTION OF ARSENIC FROM MAGENTA RESIDUES.—M. Cl. Winckler's process consists in supersaturating with soda the mother-liquors from the purification of magenta contained in the crude product as arseniate of rosanilin, and on the reduction of the arseniate of soda by charcoal in presence of carbonate of lime.—*Chemisches Centralblatt.*

CLEANING THE DAGUERREOTYPE.

By W. L. SHOEMAKER.

IT certainly is a matter of vain regret that one feels on removing a daguerreotype from its case, that a specimen that represents such a wonderful era in the graphic art should be subjected to ruthless handling by many professionals of the present.

We have had pictures of every kind brought to us for for copying, and I find the daguerreotype the worst abused of all.

Although never having followed the art of daguerrotypy, having become apprenticed at the time of its decline (1859) in this city, still I appreciate and admire the wonderful results that often pass through my hands, and to see a picture without being sealed, no preserver, dusty, finger-marked, is enough to make one swear.

A photographer in the West, for whom we have done a great deal of copying, sent us a package, consisting of a large number of daguerreotypes and ambrotypes. Each were taken from their cases, their mats, glass and preservers removed, each wrapped in a little piece of tissue paper, the whole enclosed in a paper box; when received the ambrotypes were broken to *flinders*, and I had to practise the mosaic art to repair damages; the daguerreotypes scratched to destruction. I am not a practical swearer, or I should have tried my hand at it on that occasion.

About three years ago, two frames of daguerreotypes, each containing about (100) one hundred one-sixth size pictures were sent to us to clean and replace.

These pictures were placed in a velvet matt without sealing; the action of the gases of the atmosphere had obliterated most of the pictures, and they were unrecognizable.

To clean them and replace in the matt would have been easier than any other method, but I desired to make them a permanent thing if I could, and tried the following experiment: first removing, brushing off all loose particles, then immersing in a dish of *hot water*; this removed all gum from sticking paper on back, and softened the coating on surface quickly, so that on laying in a dish of *weak* cyanide, they cleaned nicely; after washing *well*, I poured over the surface *raw albumen*, gave a slight rinse under a small flow of water, then set up to dry spontaneously. After *thorough* drying each was placed in a dish of alcohol for a few minutes; this caused the albumen to be made insoluble, or, in other words, cooked it.

If the albumen is moist in the least degree when placed in the alcohol, the surface will dry opaque, and trouble will be given to remove it, but if the surface albumen is thoroughly dry it will remain transparent, and dry spontaneously.

This method I found left a good coating on the surface, and could be rubbed quite hard without marking.

I hesitated making this public at that time, as I desired to wait and see if they returned to their original condition, but on examining them a few weeks since, I find them all good yet, no change having taken place. I felt doubtful myself at the time, for all who have cleaned daguerreotypes, although they may have sealed them properly when putting them up, will know that a picture once cleaned is more liable to change than ever, if not very carefully washed.

My object in occupying your valuable space is not to intrude advice, but rather to relate my experience in the above case, as I aided in the preservation of a number of pictures not valuable in themselves, but for their association, as they represent a body of men, very few of whom are among the living, and were greatly appreciated by their owners.—*Philadelphia Photographer.*

UNALTERABLE SILVER BATH.

HERE is the formula of a silver bath that the inventor gives as unalterable:

Nitrate of Silver	2.50 grammes (38 grs.)
Nitrate of Soda	1.25 " (19 grs.)
Ammonia	(2 drops)
Wood Alcohol	$7\frac{1}{2}$ c.c. (2 fl. drs.)
Water	30 " (8 " ")

The paper is floated in the bath for three or four minutes. As soon as the operation is finished the bath is poured into a bottle, and kept well corked.—*Bulletin Belge.*

EMULSION MANIPULATIONS.

By H. J. NEWTON.

ALTHOUGH so much has been said and written on the mode of developing and the general manipulation in the production of an emulsion negative, there still appears to be a call for light, and from some quarters this cry is fierce and sharp. The fact appears to be overlooked by some that by making a conspicuous display of their failures, they put themselves in strong and unfavorable contrast with those who succeed, and to a great extent justify adverse criticism as to their intellectual capacity.

To avoid the necessity of answering some correspondent almost every day, I will give in minute detail my mode of manipulation in producing an emulsion negative.

First, prepare the plate either with albumen or talc. If with albumen, prepare it as follows: White of one egg dissolved in eight ounces of water; after the solution is complete, add eight ounces of water, to which has been added sixteen drops of carbolic acid. Ammonia in the albumen should be avoided. If talc is used, clean the plates with undiluted sulphuric acid; wash well, and wipe dry with a clean cloth which has been washed in water containing washing soda instead of soap, and when dry apply the talc. If the plate is to be exposed and developed while wet, place it in clean water as soon as the film has set, and let it remain until the greasy lines are washed off (after this is accomplished it will not injure it if it remain in water for a week); expose, and before developing flood the surface with water, in order that the developer may flow smoothly over the surface. A quantity of the soda solution, sufficient to cover the plate, is poured into a wide-mouthed vial, and just before using, a few grains of pyrogallic acid are put into it, which dissolves in a few seconds by agitating the same; then flow over the plate. The flowing of the plate with the developer can be done moderately, as nothing is gained by dashing it on, as many do the iron developer in developing a bath negative. If the plate has been over exposed, the appearance of the negative on the application of the developer will be the same as that of a bath plate.

I would advise any one commencing the use of emulsion to expose one or more plates in this way: Prepare a plate, and give it three exposures by drawing the slide so as to expose one-third of the plate, and after ten seconds draw it so as to expose two-thirds of the plate, and give this ten seconds, and then draw the said slide so as to expose the whole plate, and give this ten seconds. In this way the first part of the plate gets thirty seconds, the middle part twenty seconds, and the last ten seconds. By developing a plate so exposed you can approximate very near the proper time for the light you are working in.

The great variation in the actinic force of light in different localities is a fact, to a great extent overlooked by photographers. The light from the rear windows of my residence in the yards between the residences on Forty-second and Forty-third streets is at least twice as strong in actinic force as that in the Central Park, three-quarters of a mile away. Before going to the Park to expose plates, I always expose a small plate from my window at the rear of my house, and if fifteen seconds makes a good negative, I invariably give from thirty to forty seconds in the Park. The most striking illustration, however, of the difference in different localities of the actinic force of light I observed in making negatives at Niagara Falls. Plates which required thirty seconds' exposure in New York were fully exposed at the Falls in from three to six seconds.

From these facts it will be observed that, when one attempts to state definitely how much exposure should be given for a specific quantity of emulsion, the chances are that he would only mislead; for this it becomes necessary to expose a plate as above directed, and thus determine the action of light in which the emulsion is exposed.

If the plates are to be used dry, the process of development is the same. The plate should be thoroughly washed before applying the developer. I usually, however, flow the plate after washing with a pyrogallic acid solution, from three to six grains strong, until the faint outlines of the image appear. This pyro solution can be used repeatedly for several hours.

I determine in this way whether the exposure has been long or short. If the image comes out quickly and has a reddish appearance, it indicates an over-exposure. I then reduce my soda solution by adding a small quantity of water, in the first place one-fourth, and determine by its action how to treat the next plate.

Some failures to get good negatives from emulsion have been caused by washing the plates in water unfit for the purpose. Organic is less objectionable than mineral substances in the water. Water from melted ice is always good for this purpose.

The greater the quantity of pyrogallic acid used, the more intense will be the negative. There is, of course, a limit to this effect of pyro. If the negative after fixing needs strengthening, use the iron and citric acid as follows:

No. 1.

Water	16 ounces.
Protosulph. iron	1 ounce.
Citric acid	$\frac{1}{2}$ "

No. 2.

Water	1 ounce.
Silver	20 grains.
Nitric acid	6 drops.

Pyro and citric acid can be used, but are more likely to produce stains, and in my hands are not so satisfactory as the iron.—*Photographic Times.*

PHOTO HINTS.

1. *Plate Cleaning.*—The best plate cleaning solution is the water in which potatoes have been boiled. In this water boil your glass plates, and rinse; you will find them much better cleaned than with soda or potass. Try it.

2. Never make your silver nitrate of pieces of silver which have been electro-plated. This year we made some nitrate with fragments of a set of teeth gilded by galvano-plastic, expecting the silver to dissolve and leave the gold intact. But it is not so; and the gold seemed to be dissolved with the silver, as it was not visible in the nitrate. When the nitrate was used in the negative bath we tried and found the plate covered entirely with minute pinholes. The bath solution seemed clear and limpid, but when seen in the sun with a ray falling on the bottle, we saw thousands of minute atoms of gold reflecting and floating in the solution. Filtering was no cure; precipitating as carbonate, no cure; as a chloride the particles did not pass the filter, but rested on it. We then converted the bath into metallic silver by copper plates, as indicated by Captain Abney's Manual, and at the first conversion we still found gold in the nitrate.

3. The simplest way for amateurs of reducing silver wastes is to throw the silver containing solutions (except hypo) on sawdust mixed with ash of paper, and then place a Paris clay crucible with a little borax and nitrate of potass; the wood and nitrate of potass will form carbonate of potass (pearlash). When the flux is limpid as water, and black as jet, flow on dry sand; when cool, you will find pure silver. When the sawdust used is not sufficient to black the flux, put in the crucible a wood stock, which will set all right.—*Photo News.*

PHOTOGRAPHY BY LIGHTNING.

ON June 10th a severe thunderstorm visited Ramsgate, England. The lightning being very vivid, I tried to obtain a photograph, and succeeded perfectly after sensitizing a quarter plate in the ordinary way. I placed it at the back of a negative. Four flashes were counted, and upon developing up came the image as clear and as quick as if taken by ordinary daylight. One flash with a weak negative gave a fair transparency. I next tried with the camera; after getting everything nicely in focus through my studio window, which was done by the aid of lightning, I obtained a photograph with twenty flashes, the view being the back of Queen street, Ramsgate. This, I think, shows most clearly that the chemical power of lightning is quite equal to the electric light produced artificially, and nearly equal to daylight. As this is the first time I have ever heard of a photograph being taken by lightning, I thought it worth communicating to the *Photographic News.* A. J. JARMAN.

CLEANING OF PLATES AND LENSES.

ALL persons who work in photography know, or should know, that to clean lenses, and preserve the polish of their surfaces, they should not be wiped with a cloth, but after having removed the dust by means of a brush, they should be covered with a thin coating of grease, then wiped with a piece of very soft chamois. An amateur asserts that for this purpose there is nothing better than chicken grease. Without contesting the merit of this fatty body, we simply use tallow, which we recommend not only for lenses, but also for plates which are to be collodionized.

The dealers in glass plates for cliches coat them with grease, and simply wipe them before delivering them to photographers, and it is known that these plates generally give very pure cliches without any other cleaning.

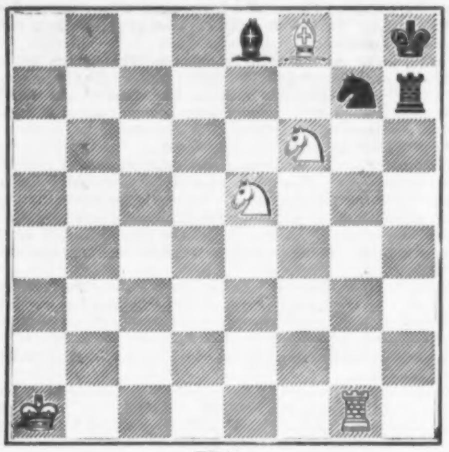
THE lightning struck the stables of the Gentlemen's Driving Park Association, in Bergen county, N. J., and killed four horses. One of them was Huntington's trotter, for which $10,000 was recently offered.

SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department, may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 11.—BY ANDERSON.

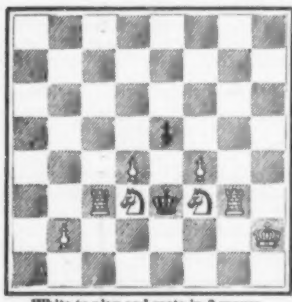
Black.



White.

White to play and mate in three moves.

THE LEIPZIG CHESS CONGRESS.



White to play and mate in 3 moves.
BY DR. C. C. MOORE.

ADOLPH ANDERSON, whose portrait we give this week, was born at Breslau, July 6, 1818. In 1851 he defeated Kieseritzki, Staunton, Szen, Wyvill and Williams, and carried off the first prize in the London Tournament. In the same year he won the cup in the London Chess Club Tourney, defeating Lowenthal, Horwitz, Harrwitz, Kling, Deacon, Ehrmann and others. In 1857 he gained the second prize at Manchester. In 1861 he defeated Herr Kolisch and in 1862, at London, he won the first prize in the general tourney and the third in the handicap. In 1858, however, Herr Anderson lost to Morphy, and in 1866 to Steinitz, in regular matches. In 1870 he gained the first prize at Baden, but in 1871 succumbed to Zukertort, and in 1873 secured only the third prize at Vienna, Blackburne and Steinitz preceding him.

Selections from these several matches will appear in due course of time in our columns. For many years Herr Anderson was considered the most skillful problemist of his day, and although of late years he has neglected this higher branch of the art, still many of his compositions compare favorably with those of the most celebrated modern composers; and to this problematical experience is unquestionably due his great strength as a player: it being a noted fact that all the great problemists have been strong players. We give two of his prob'ems from memory, although better selections might perhaps be made. The two games we select were played at Simpson's Divan in 1851, and are considered unrivalled specimens of brilliant play.

The Leipzig Chess Congress was opened on the 15th of July, by a preliminary meeting, Privy Councillor Dr. R. Gottschall in the chair. The master's tournament, and the chief tournament of amateurs, began Monday, July 16, at 9 A.M., and were continued up to Saturday, the 21st. This hard work was interrupted Wednesday afternoon, which was devoted to a banquet in honor of Anderson. The splendid repast was followed by the presentation of a column to Anderson. The pedestal of this exquisite present bears on one side the inscription: "London, 1857; London, 1862; Baden-Baden, 1870;" on the other, the ending position of Anderson's last game with Staunton. The column is headed by Caissa presenting an iron crown. Numerous other presents were made—silver cups, diplomas of honorary membership, letters and telegrams of congratulation, etc. In the master's tournament twelve gentlemen entered, with the following result, draws being counted as half games;

L. Paulsen, 9,	Leffman, 5.
Anderson, 8½,	Schallopp, 5.
Zukertort, 8½,	Metger, 3½.
Winawer, 7½,	Flesig, 3.
Goring, 6,	W. Paulsen, 2½.
English, 5,	Franke, 2½.

In playing off the tie, Anderson defeated Zukertort, winning the second prize. The three prizes were $100, $50, and $25. The amateur tournament was brought to a conclusion early in the week, and the four prizes were taken in the following order: Wemmer of Cologne, Dr. Schmidt of Dresden, Dr. Knorre of Berlin, and Forte of Gressing. In the problem tournament connected with the Congress, the two prizes were taken by Berger of Graz, and Colcolusch of Prag. The play was concluded by a consultation game, in which L. Paulsen, Dr. Goring, and Herr Metger were beaten by Anderson, Zukertort, and Dr. Schmidt. Immediately after the conclusion of the tournament, a match for the first five games was arranged between Anderson and L. Paulsen. The score stands Anderson, 1, Paulsen, 0.

It is worthy of mention that after each tournament in which Anderson has defeated Paulsen, our Dubuque boy has reversed the decision in a set match. We hope to be able to give the result as well as the decisive game of this important encounter in our next week's issue.

THE BRITISH COUNTIES CHESS ASSOCIATION.

THE following is the result of the recent interesting meeting, which is all we can give at present, not yet having seen any specimens of the games.

FIRST CLASS.

First Prize.—Mr. J. Jenkin, Glasgow.
(*The Provincial Challenge Cup.*)
Second Prize.—Professor Wayte, London.
Third Prize.—Mr. Thorold, Bath.

SECOND CLASS.

First Prize.—Mr. J. F. Ryder.
Second Prize.—Rev. W. L. Newham.
Third Prize.—Mr. Wallbank.

THIRD CLASS.

First Prize.—Mr. A. H. Griffiths.
Second Prize.—Mr. A. Michael.

HANDICAPS.

First Prize.—Rev. C. E. Ranken.
Second Prize.—Rev. C. R. Pierpoint.

Next meeting will be held in London, in 1878. President, Mr. John Cochrane; Secretary, Rev. C. E. Ranken.

ADOLPH ANDERSON.

[We have taken the liberty of puzzling the great German master by placing a little three-move problem on the board; our solvers must bear this in mind and not fail to send correct solutions.—ED.]

(KING'S BISHOP'S GAMBIT.)

WHITE. PROF. ANDERSON	BLACK. MR. KIESERITZKI.
1. P to K 4	1. P to K 4
2. P to K B 4	2. P x P
3. B to B 4	3. Q to R 5 ch
4. K to B sq	4. P to Q Kt 4 (*a*)
5. B x Kt P	5. Kt to K B 3
6. Kt to K B 3	6. Q to R 3
7. P to Q 3	7. Kt to R 4
8. Kt to R 4	8. Q to Kt 4
9. Kt to B 5	9. P to Q B 3
10. P to K Kt 4	10. Kt to B 3
11. R to Kt sq (*b*)	11. P x B
12. P to K R 4	12. Q to Kt 3
13. P to R 5	13. Q to Kt 4
14. Q to B 3	14. Kt to Kt sq
15. B x P	15. Q to B 3
16. Kt to B 3	16. B to B 4
17. Kt to Q 5 (*c*)	17. Q x Kt P
18. B to Q 6 (*d*)	18. Q x R ch
19. K to K 2	19. B x R (*e*)
20. P to K 5	20. Kt to Q R 3 (*f*)

White gives checkmate in three moves.

NOTES BY W. N. POTTER.

(*a*) This, when made on the third move, constitutes Kieseritzki's Counter Gambit.

(*b*) Brilliancy No. 1. He expects an equivalent from the confined position of his adversary's queen.

(*c*) Submitting to both his rooks being placed *en prise.*

(*d*) And now giving them both up, after which he will be the two majors and a minor piece behind.

(*e*) 19. Q to Kt 7 is apparently better. Anderson's reply would have been K to Q 2, threatening to win the queen by R to Q Kt sq.

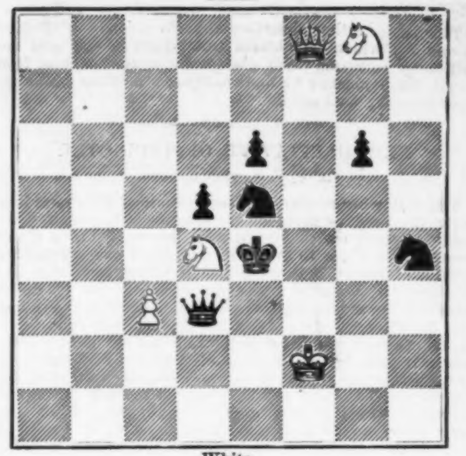
(*f*) Preventing the mate in two, but overlooking the very fine one in three moves that lay hidden in the position. The only way of prolonging the game, so far as I can see, was 20. B to R 3, the response to which would be 21. Kt to B 7 ch, and 22. Kt x B, leaving white with a clear win, for black will lose much more then he has gained, or else be mated.

This has been called the "immortal game," a transcendental form of eulogy which I shall hold myself excused from using. Suffice it to say that for brilliancy and depth it stands absolutely peerless.

The proposed programme for the American Chess and Problem Association is being prepared and will be ready in the course of a couple of weeks; the treasurer expects quite a number of new members. We trust that all who intend participating, or take any interest in the affair, will promptly enroll their names.

PROBLEM No. 12.—BY ANDERSON.

Black.



White.

White to play and mate in three moves.

(EVANS GAMBIT.)

WHITE. PROF. ANDERSON.	BLACK. HERR DUFRESNE.
1. P to K 4	1. P to K 4
2. Kt to K B 3	2. Kt to Q B 3
3. B to B 4	3. B to B 4
4. P to Q Kt 4	4. B x Kt P
5. P to B 3	5. B to R 4
6. P to Q 4	6. P x P
7. Castles	7. P to Q 6 (*a*)
8. Q to Kt 3	8. Q to B 3
9. P to K 5	9. Q to Kt 3
10. R to K sq	10. K Kt to K 2
11. B to R 3	11. P to Kt 4
12. Q x P	12. R to Q Kt sq
13. Q to R 4	13. B to Kt 3
14. Q Kt to Q 2	14. B to Kt 2
15. Kt to K 4	15. Q to B 4
16. B x Q P	16. Q to R 4
17. Kt to B 6 ch	17. P x Kt
18. P x P	18. R to K Kt sq (*b*)
19. Q R to Q sq (*c*)	19. Q x Kt
20. R x Kt ch	20. Kt x R.

White mates in four moves.

NOTES.

(*a*) Played by Herr Steinitz with much success, but otherwise it does not appear to be a prosperous defense.

(*b*) The disposition of black's forces suggests the idea that white's 17th move was not only expected but desired by Herr Dufresne. Certainly his position looks very menacing.

(*c*) This very remarkable move not only paralyzes what is more obviously threatened, viz., Q takes Kt, but completely commands the board. White, in fact, wins in every variation.

SOLUTIONS TO PROBLEMS.

NO. 5.—BY HARRY BOARDMAN.

WHITE.	BLACK.
1. B to K 6	1. P x B.
2. B to Q 8	2. Any move
3. B mates	
	1. Q x R
2. Kt x B ch	2. Q interposes
3. R x Q mate	

NO. 6.—BY HARRY BOARDMAN.

1. B to K Kt sq	1. R to K 7
2. Q x B mate	
	1. R to K 5
2. Kt to B 3 mate	
	1. R elsewhere
2. Q to K 3 mate	
	1. R to K 3
2 R to B 5 mate	
	1. R elsewhere.
2. Q to K 7 mate	
	1. Q Kt moves
2. Kt to B 6 mate	
	1. K Kt moves
2. Q to Q 6 mate	
	1. B to Q 5
2. B to R 2 mate	
	1. B elsewhere
2. Q x B mate	
	1. P to R 6
2. Q to K Kt 3	
	1. P x Kt
2. Q to Q B 5 mate	

LETTER "B," BY HARRY BOARDMAN.

1. R from K 3 to Q B 3	1. Kt to Q 7
2. Kt to K 3 mate	
	1. Kt x R
2. Kt x Kt mate	
	1. Any other move
2. R to Q R 5 discovers mate	

MR. TEED, the umpire of the Hartford *Globe* Problem Tournament, has just made the following satisfactory awards:
First Prize.—Rev. L. W. Mudge, of Princeton, N. J.
Second Prize.—Ben. S. Wash, of Chicago.
Third Prize.—F. W. Martindale, of Peterborough, N. Y.
Fourth Prize.—R. H. Seymour, of Elizabeth, N. J.
Fifth Prize. -Col. X. Hawkins.
The prize for the best problem of the tournament was awarded to Ben. S. Wash. A selection of the problems will be given.

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